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A Comparative Study of Measurements and Qualitative Ratings of Nursery School Children

ELISE HATT

INTRODUCTION

THIS paper reports the results of a study undertaken at the Merrill-Palmer School[1] with the purpose of showing the efficiency of a profile based upon percentiles, the Biogram, in indicating the relative superiority or inferiority of individual nursery school children. In studying this point, a comparative study was made of the Biograms of two groups of nursery school children, one group considered by adults observing them in the nursery school to be "most desirable," and the other group "least desirable," from an all-round point of view, in order to determine (1) what traits best differentiate the two groups of children and (2) the relative importance of the different traits in determining what is regarded as "desirability" and "undesirability." These terms were considered more appropriate than "superiority" and "inferiority" to indicate the differences among children who as a group are superior. They are used throughout in a relative sense. The final value of such a study is, of course, to find out whether it is possible to integrate many diverse data—mental, physical, and social—in such a way that the cumbersome and time-consuming qualitative summaries concerning the child can be replaced in part by a graphic summary which is at once more simple and more efficient in conveying an impression of the child's status in all the traits measured. Finally, there is a short discussion of a few individual children whose ranks on the Biogram differed from those given them by the adult observers; these cases were studied to determine what measures may be added to the present quantitative records to eliminate this discrepancy between the subjective impression of the child and his quantitative record.

BACKGROUNDS OF THE STUDY

The integration of the quantitative data on the Merrill-Palmer nursery school children has for some time presented a problem. The number of measurements taken has increased until now, after seven years of record-taking (1922 to 1929), over fifty different kinds are made. Before a method of synthesizing the data had been developed, the reports upon individual children included the monthly record of weight and height sent to the parents; the weekly summary of certain factors distributed to the staff; and a complete narrative report of the child, based upon all the records, which is sent to the parents at the time of the child's withdrawal from the nursery school, but is not available when it is most important to the School—while the child is still under its care. Aside from these reports, there have been occasional elaborate analyses of all the data on certain children for special use at the School or for presentation before professional groups. These analyses, however, had disadvantages: They were unwieldy; they could be issued only occasionally because of the time required to make them; they included only a few children; and since the data were in different units it was difficult to synthesize them mentally to gain an idea of the child's developmental status as a whole, and, indeed, an adequate interpretation of the different data could be given only by students in the fields represented. Some method of bringing these data together was needed which would permit describing the child as completely as feasible in easily interpreted quantitative terms and which would be concise enough to permit making such a summary for each child at regular intervals.

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[1] The author is happy to acknowledge her indebtedness to Dr. H. H. Remmers, whose study *A Diagnostic and Remedial Study of Potentially and Actually Failing Students at Purdue University* was helpful in the present analysis; and to the staff of the Merrill-Palmer School, especially to Miss Mary E. Sweeny and Dr. Rachel Stutsman, for their advice during the course of the study, Miss Leone E. Chesire, whose statistical work in compiling the percentile tables of *The Merrill-Palmer Standards of Physical and Mental Growth* is the indispensable basis for the present paper, and Miss Dorothy Tyler, who prepared the manuscript for publication.

Accordingly, to facilitate interpretation and comparison, all the physical, psychological, social, and environmental data that furnished statistically adequate material (that is, a sufficient number of cases) were reduced to a common unit, the percentile rank. This method was chosen because it does not assume a normal frequency distribution in the data, an exigency that had to be provided for, and because it is readily understood by those untrained in statistical methods and so was of definite advantage in making the material readily accessible to parents, students, and staff. The traits for which sufficient data were available to permit the construction of percentile tables of standards were the following:

Standing Height
Weight
Weight-Height Index
Stem Length
Recumbent Length
Stem-Stature Index
Stanford-Binet Mental Age Values
Merrill-Palmer Scale Scores
Goodenough Drawing Test Scores
Scores on Monroe Drawing Scale
Scores on Merrill-Palmer Personality Rating Scale
Activity Ratings (Merrill-Palmer Scale)
Diet:
  Energy Intake (Calories)
  Protein Intake (Grams)
  Fat Intake (Grams)
  Carbohydrate Intake (Grams)
Time Required to Eat Lunch
Time in Bed at Night
Regularity of the Night Bed Hour
Absences: Causes
  Colds
  All Illnesses

In all traits where there is likely to be a sex difference, separate tables were constructed for boys and girls, and in the case of the Stanford-Binet and

Merrill-Palmer scales separate tables were prepared for the first test and subsequent retests, to provide for the practice effect obtaining from the first test to the second and continuing through the fourth retest. In all, therefore, percentile tables were constructed for twenty-nine different factors relating to the child. These percentile tables of standards, together with a full account of the records upon which they are based and the statistical significance and use of the tables, are available in a bulletin entitled *The Merrill-Palmer Standards of Physical and Mental Growth* (14).

A brief discussion of the present percentile standards will indicate their general derivation, significance, and use.

The Standing Height standard shows the percentile rank of the child's height as compared with that of other children of the same sex and age in months. The Weight for Height standard compares the child in mass to other children of the same height and sex, irrespective of age, and the Weight-Height Index compares the child's rank in this trait to that of other children of the same age. In the Stem Length, Recumbent Length, and Stem-Stature Index standards, the child is compared to children of the same age and sex. The stem length is the length of the body from the top of the head to the buttocks (the "crown-rump length" in the terminology of Boyd (1)), and the recumbent length, like the standing height, is a measure of total body length, taken in a supine position. The stem-stature index measures the child's body type, whether stocky or long limbed.

In the Stanford-Binet and Merrill-Palmer scale standards, and in the Goodenough test (3) standard, which is based upon ratings of the child's drawing of a man as compared to a scale and is regarded as a measure of intelligence, the child is compared to children of the same age in months; in the Stanford-Binet and Merrill-Palmer scales he is compared also with children who have had the same relative experience with the tests as himself—that is, there is one standard for the first test and another for subsequent retests up to the fourth.

In the Merrill-Palmer Personality Rating Scale standard the child is compared with other children in five types of behavior, i.e., Effective Energy, Mental Effectiveness, Emotional Control, Social Adjustment, and Skill in Work and Play (14, pp. 18–21). In the Merrill-Palmer Activity Rating Scale (10) standard the child is compared to all other nursery school children (not those of his own age only) in fifteen types of activity, according to a five-point scale indicating the intensity of the activity. In the Time to Eat Lunch standard, a measure of the child's dispatch in this matter, the child is compared with other children of the same age in years. The time the child takes to eat lunch (when the age is held constant) is partly a measure of appetite, partly of a general tendency to dally, and partly of sociable or mischievous behavior; indirectly, it is a measure of the amount of trouble the child gives the nursery school teachers, for continual dawdling in this part of the program calls for much patience and tact from the adults in the nursery school. In the Time in Bed at Night and Regularity of the Bed Hour standards, the child is compared with children of the same age in years; and in the standards measuring the child's relative freedom from colds and all illnesses, respectively, the child is compared with the younger (24 to 41 months) or older (42 to 59 months) of two preschool age groups, according to his age. In the Biogram some of the terms used for the traits measured have been changed slightly from those used in the *Standards* (14), partly to secure brevity and partly to indicate that the Biogram shows an individual *rating*, while the standard shows, more strictly, a distribution of measures. In the Diet standards (calorie, and protein, fat, and carbohydrate intake in grams per pound of body weight), the child is compared with other children of the same age in months. In the Monroe Drawing Scale standard, the quality of the child's free-hand paintings in the nursery school is compared with that of other children of the same age in months on the basis of a rating scale (6).

Since the standards are based upon data for the Merrill-Palmer nursery school children, a superior group, it is probable that a group more nearly representative of the general population would show different distributions and averages (14, pp. 9–10, 35). It is also probable, however, that the Merrill-Palmer group is fairly representative of the nursery school population connected with child development research centers.

The reduction of the data to a common unit and the determination of percentile standards made it possible to show the ranking of the individual child in any trait in relation to that of all other Merrill-Palmer children (or those of the same grouping) in this trait, and to integrate these ranks into as complete a quantitative picture of the child as the thoroughness of the measures now taken will permit. To give this "quantitative picture" a graphic form, the "Biogram," similar to the "psychograms" used in the mental testing field, was devised (fig. 1). Ideally, the Biogram attempts to give a complete quantitative picture of the preschool child at a given age—showing his rank in many traits relating to physique, mentality, personality, habits, and environment. Actually, the Biogram at the present time shows the rank of the child in several anthropometric factors; three mental tests; a personality rating scale; an activity rating scale; health; such physical habit factors as amount and regularity of sleep and dispatch in eating the school lunch; diet; and one measure of aesthetic aptitude, the child's rating in free-hand painting. Until the items included in the Biogram are themselves sufficient to describe the child, it is intended that each Biogram shall be accompanied by a qualitative description, furnishing such additional facts as are significant. It is probable that supplementary notes will always be necessary when a complete record is desired.

In judging the status of the child as measured by his percentile rankings and as indicated by the Biogram, some classification of inferior, average, and superior zones and an idea of the position of the optimum in the various traits are of course necessary as a standard of comparison. Though further study is needed to establish the position of the optimum in some traits

BIOGRAM

MERRILL · PALMER SCHOOL

Name. OPTIMUM

Age (months) ANY. PRESCHOOL .CHILD..

	MEASUREMENTS	WEIGHTING ASSIGNED
1.	Height for age	
2.	Weight for height	3
3.	Stem length for age	
4.	Recumbent length for age	
5.	Stem-stature index	
6.	Stanford-Binet Mental Test	
7.	Merrill-Palmer Mental Test	3
8.	Merrill-Palmer Personality Rating Scale	
9.	*Effective energy or strength*	4
10.	Mental effectiveness	3
11.	Emotional control	3
12.	Ease of social adjustment	3
13.	Skill in work and play	3
14.	Merrill-Palmer Activity Rating Scale	
15.	Total outdoor activity	1
16.	Total indoor activity	
17.	Dispatch in eating lunch at school	1
18.	Freedom from colds	
19.	Freedom from illness	
20.	*Hours in bed*	
21.	Hours asleep	
22.	Regularity of bed hour (S. D.)	2
23.	Calories per lb. of body wt.	
24.	Protein, per lb. of body weight	
25.	Fat, per lb. of body weight	
26.	Carbohydrate per lb. of body weight	
27.	Monroe Drawing Scale	
28.	Weight-height index	
29.	Goodenough Test	
30.		
31.		
32.		
33.		
34.		
35.		

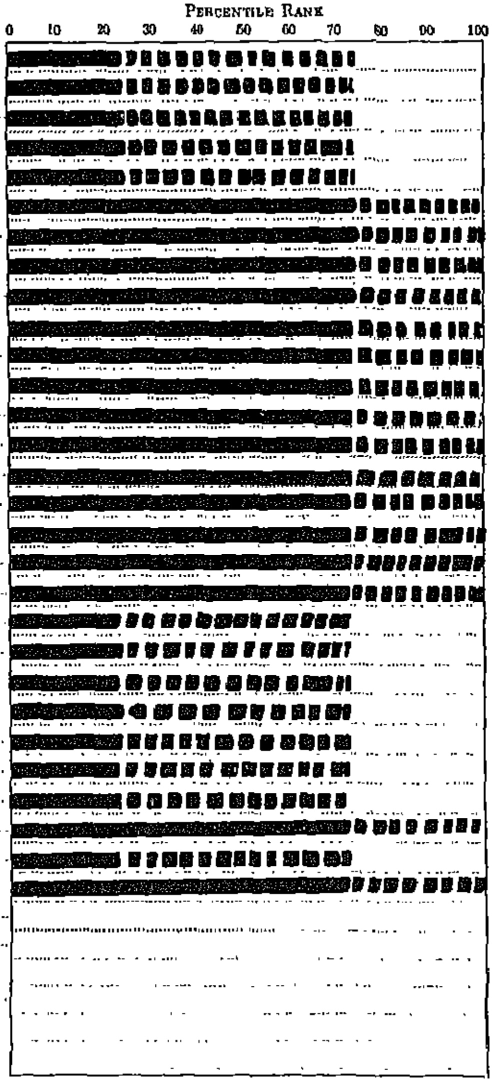


FIG. 1. BIOGRAM SHOWING OPTIMUM RANKS IN PERCENTILES

and to fix the limits of the three zones in all traits, these points can be determined roughly. The percentiles are all arranged from 1 to 99, and superiority in a trait is in general indicated by a high percentile rank (right end of the scale), and inferiority by a low rank (left end of the scale) (fig. 1). In some traits, however, the median probably represents the optimum, e.g., in any measure of body proportion. In body weight, for instance, *a rank in the first quartile is probably* less desirable than a rank in the highest quartile; but a rank in the highest quartile is, in turn, less desirable than a rank in the second or third quartile. The reason for placing the optimum for body weight in the interquartile range is fairly obvious. A decision concerning the optimum position for the measures of body length is less important. It was decided *that from an aesthetic point of* view, at least, the optimum in these traits was best placed in the interquartile range. We have assumed (fig. 1) that the median is also the optimum in the following traits: sleep (hours in bed, hours asleep, and regularity of the bed hour), and diet (calories, and protein, fat, and carbohydrate intake in grams per pound of body weight). There were insufficient data on the food intake of the children included in the study to permit the inclusion of a ranking on these traits.

It was difficult to locate the optimum in two traits; namely, dispatch in eating lunch and activity. The optimum for dispatch in eating lunch has been placed in the upper quartile; that is, it is considered that the more rapidly a child finishes his meal, the more desirable is his behavior in this respect. Certainly this is true if the adults in charge of the child are to be considered. But, more important, experience shows that a dispatch in eating lunch that places the child in the upper quartile is advantageous to him. The time corresponding to the 99 percentile in this trait—that is, the time spent at lunch by the most rapid eaters among the four-year-olds—is 19 minutes. Members of the physical growth staff who have watched many nursery school children say that a child who finishes in nineteen or twenty minutes the amount of food given him is not gulping his food or failing to masticate; rather, this dispatch in finishing the meal indicates a good appetite, skillful motor control, and a lack of dawdling or mischievous behavior. The present position of the optimum in activity—in the upper quartile—is also controversial. Theoretically, it is as undesirable for the child to be hyperactive as to be hypoactive. However, it was found that the children who were considered relatively superior tended to rank much nearer to the 75 percentile than to the 50 percentile in outdoor play; and that the children who were considered relatively inferior tended to rank below the 50 percentile. Further, an examination of the percentile table for activity shows that, while the scale has five points, the upper points are little used in rating children or, at least, tend to disappear in the averaging process. The 90 percentile in outdoor play, for example, is 2.86, or almost 3, the theoretical midpoint on the scale. The descriptive phrases accompanying this point on the scale indicate only a healthy degree of activity, not hyperactivity.

However, while the present placing of the optimum in the various traits is probably to be considered correct for the majority of cases, it must be emphasized that in certain traits, e.g., amount of sleep, regularity of the bed hour, etc., the optimum may vary considerably in individual cases.

The Biogram has been in use since the early months of 1929 and has demonstrated its usefulness in acquainting the nursery school teachers with the children's standing in various quantitative measures taken by the staff, and thus serving as a guide in their care of individual children; as a basis for discussion of the children in classes for the students studying child care and training and in staff committees; and as a means of showing the child's parents, in a graphic way, how the child stands with reference to the whole group in all the traits measured. As an instrument of parent education, it is especially useful in showing the child's rank in items for which the home is directly responsible, i.e., sleep and food.

PROCEDURE

For the present study, intended to test the efficiency of the Biogram in differentiating children considered to be relatively superior and inferior, the subjects were chosen as follows:

A list of the 50 children registered in the Merrill-Palmer nursery school in April, 1929 was sent to 39 staff members and graduate students who knew the children best, with the request that they place a plus sign before the names of the 10 children they considered most desirable from all points of view—physical, mental, and social—and a minus sign before the names of the children they considered least desirable from the same points of view. That is, an attempt was made to secure a subjective rating which would be comparable to the objective rating of general superiority and inferiority presented by the Biogram.

The number of votes, favorable and unfavorable, for each child who had been voted for were then added algebraically and the children ranked accordingly. Seven of the 50 children originally included had to be excluded from the study because certain essential quantitative data were lacking from their records. This left 43 participating in the final ranking. The percentage of favorable votes received by the first ten of the "desirable" children (to be called the "D" group) varied from 94.8 to 48.7 per cent, while the percentage of unfavorable votes received by the first ten of the "least desirable" children (to be called the "U" group) varied from 82.1 to 41.0 per cent (table 1). That is, there was more agreement upon desirability than upon undesirability. This disagreement upon the ten "least desirable" children may be attributed to two causes. In the first place, the nursery school children, as noted before, do not represent an unselected sample of the population. The median mental age of the children on the Stanford-Binet Scale is about seven months higher than their chronological age, and an unselected group of thirty who were measured by the

Sims Scale for Socio-Economic Status showed (according to the New Haven standardization) a median percentile at the 90 percentile, an interquartile range between the 80 and 95 percentiles, and the lowest family at the 60 percentile of the Scale. The fact that the children come from relatively superior homes and would not be considered undesirable as compared to a random sampling, but are so only in relation to their more desirable schoolmates, makes the selection doubly hard for the judges and probably largely accounts for their disagreement. Secondly, both the staff and students are keenly interested in and analytical of each child in the nursery school, and so no child appears to be without virtue. Only 1 of the 10 D children had less than a majority of votes, while 5 of the 10 U children had less than a majority of votes. None of the 43 children received less than 3 votes, whether favorable or unfavorable. However, among the 10 D children, only one child, 10-D, received any unfavorable votes. For convenience, the child who received the greatest number of favorable votes will be designated as 1-D, the one who received the next highest number as 2-D, etc.; the children of group U are similarly designated as 1-U (the child

TABLE 1

Number and percentage of favorable and unfavorable votes received by the children of the D and U groups

CHILD	SEX	AGE MONTHS*	FAVORABLE VOTES		UNFAVORABLE VOTES		NET VOTES	
			Number	Per cent	Number	Per cent	Number	Per cent
1-D	F	60	37	94.8	0	0.0	37	+94.8
2-D	F	59	35	89.8	0	0.0	35	+89.8
3-D	M	46	33	84.6	0	0.0	33	+84.6
4-D	F	55	30	77.0	0	0.0	30	+77.0
5-D	M	45	29	74.4	0	0.0	29	+74.4
6-D	M	60	26	66.7	0	0.0	26	+66.7
7-D	F	40	22	56.4	0	0.0	22	+56.4
8-D	F	53	22	56.4	0	0.0	22	+56.4
9-D	F	24	21	53.8	0	0.0	21	+53.8
10-D	M	55	19	48.7	2	5.1	17	+43.6
1-U	F	58	0	0.0	32	82.1	32	−82.1
2-U	F	43	0	0.0	28	71.9	28	−71.9
3-U	F	30	0	0.0	27	69.2	27	−69.2
4-U	F	51	0	0.0	24	61.6	24	−61.6
5-U	M	59	0	0.0	20	51.4	20	−51.4
6-U	F	54	0	0.0	19	48.7	19	−48.7
7-U	F	54	1	2.6	19	48.7	18	−46.1
8-U	M	47	0	0.0	17	43.6	17	−43.6
9-U	F	34	0	0.0	16	41.0	16	−41.0
10-U	F	53	1	2.6	16	41.0	15	−38.5

* Age on March 1, 1929; the Biograms were made from two to four months earlier.

who received the greatest number of unfavorable votes), 2-U, etc. (table 1). One of these two unfavorable votes was given by a student who was especially successful in the nursery school and the other by a Japanese student. There is some reason to suppose that child 10-D, who is extremely negative to student authority, might seem undesirable to some persons because of this trait. Among the U children, two (7-U and 10-U) each received one favorable vote. Both of these votes were given by two members of the staff who knew the children in a special situation (the medical and psychological examinations) rather than in the nursery school.

The predominance of girls in both D and U groups, but especially in the U group, is perhaps not significant, owing to the small number of cases. However, it may be suggested that the judges, all but one of whom were women, might have been more sensitive to the virtues and faults of children of their own sex and might therefore be likely to place them at the extremes of desirability and undesirability. There were equal numbers of boys and girls in the nursery school at the time the study was made.

The median age of the D group at the time the votes were cast (table 1) was 54 months, and of the U group, 52 months, while that of the entire 43 children included in the study was 46 months. That the D and U children were selected from among the older children is probably to be attributed to the more defined traits of older children as compared with younger ones. The fact that about half the judges who were staff members had known the older children over a longer period of time than they had known the younger ones may also have been a factor.

To summarize: The 10 children of group D have distinct virtues and the 10 children of group U have distinct faults which make them appear, to the 39 adults who judged them, relatively desirable or undesirable.

Owing to the small number of cases, statistical formulas could not be used in comparing the two groups. It appeared to be most fruitful to make two simple comparisons of the two groups in each of the traits measured, as follows:

1. The distribution of the percentiles of the D and U groups among the quartiles of the percentile scale.
2. The median percentiles for the D and U groups, respectively (fig. 2).

FINDINGS

Differences between the Superior and Inferior Children in Single Traits

The summary in table 2 shows the number of D and U children, respectively, in the lower quartile (below average), interquartile range (average), and upper quartile (above average), and the median percentile of each group, in each of the traits measured. See fig. 2 also.

The table shows that the D children are slightly taller than the U children, though the difference is not great. In weight, there is a marked difference in the two groups. Of the U group, 7 of the 10 children were underweight, while 6 of the 10 D children were of average weight, tending toward the

TABLE 2

Differences between the desirable and undesirable children in single traits

TRAIT	N	LOWER QUARTILE 1-24	INTER-QUARTILE RANGE 25–75	UPPER QUARTILE 76-99	MEDIAN PER-CENTILE	DIFFERENCE IN MEDIANS (PERCENTILES)
Standing Height						16
D	10	3	6	1	46	
U	10	4	4	2	30	
Weight for Height						50
D	9	0	5	4	69	
U	10	7	2	1	19	
Stem Length						9
D	10	3	6	1	43	
U	10	4	4	2	34	
Recumbent Length						16
D	10	4	5	1	44	
U	10	5	3	2	28	
Stem-Stature Index						15
D	10	1	7	2	42	
U	10	4	5	1	27	
Weight-Height Index						36
D	10	1	6	3	58	
U	10	6	4	0	22	
Stanford-Binet Test						47
D	9	0	6	3	65	
U	8	5	2	1	18	
Merrill-Palmer Test						58
D	9	0	4	5	80	
U	10	6	3	1	22	
Personality Rating						76
D	10	0	4	6	92	
U	10	7	3	0	16	
Effective Energy						76
D	10	1	1	8	90	
U	10	6	4	0	14	
Mental Effectiveness						66
D	10	0	3	7	86	
U	10	7	3	0	20	
Emotional Control						63
D	10	1	2	7	86	
U	10	6	4	0	23	
Ease of Social Adjustment						60
D	10	0	5	5	76	
U	10	6	4	0	16	
Skill, Work and Play						66
D	10	0	2	8	86	
U	10	6	4	0	20	
Activity Rating						15
D	9	1	7	1	60	
U	10	2	7	1	45	

TABLE 2—*Concluded*

TRAIT	N	LOWER QUARTILE 1–24	INTER-QUARTILE RANGE 25–75	UPPER QUARTILE 76–99	MEDIAN PER-CENTILE	DIFFER-ENCE IN MEDIANS (PERCEN-TILES)
Outdoor Activity						23
D	8	1	5	2	68	
U	10	2	7	1	45	
Indoor Activity						0
D	9	0	8	1	50	
U	10	2	7	1	50	
Dispatch, Eating Lunch						20
D	10	3	4	3	42	
U	10	5	3	2	22	
Freedom from Colds						0
D	10	1	8	1	99	
U	10	3	1	6	99	
Freedom from Illness						10
D	10	1	1	8	99	
U	10	2	2	6	89	
Number of Hours in Bed						13
D	10	2	7	1	51	
U	10	1	5	4	64	
Regularity, Bed Hour						30
D	10	0	6	4	60	
U	10	2	1	7	90	
Diet: Data not available	—	—	—	—	—	—
Monroe Drawing Test						5
D	9	4	4	1	25	
U	9	3	6	0	30	
Goodenough Test						25
D	8	1	6	1	60	
U	8	3	5	0	35	

upper quartile. It is natural that weight should have influenced the judges in their choice, since thinness is readily recognizable as presumably an index of poor nutrition, and a rosy, well-nourished child would of course be chosen as more desirable, from an all-round point of view, than a thin, poorly nourished one. Franzen (2) found that weight was mainly a product of several skeletal measurements, and that variation from the standard for a certain height did not necessarily imply nutritional deficiency, but might rather mean differences in chest and hip breadth and depth. The data for stem length and recumbent length show the D children to be slightly longer-bodied than the U children, and the data for the stem-stature index show a slight preponderance of short-limbed children in the U group. Like the data for weight, the weight-height index shows a distinct difference in the two groups, with most of the D children in the middle and upper quartiles, and the greater number of U children in the lower quartile. The differences of the two groups in anthropometric measures thus agree with those noted in *Genetic Studies of Genius* (11), where the mentally superior children were found to be taller and heavier than an unselected group of children. In the present study, however, the D and U children differed much more in body weight than in height.

The data show that intelligence plays an important part in discriminating between the two groups. Thus in the Stanford-Binet test, the median rank of the D group is 47 percentiles above that of the U group; in the Merrill-Palmer test, 58 above; and in the Goodenough test, which distinguishes less clearly between the two groups, the median of the D group is 25 percentiles above that of the U group. The Goodenough test is separated from the other mental tests on the Biogram merely because the percentile standards for this item became available later than those for the other two.

As might be expected, the personality ratings of the two groups, as measured by the Merrill-Palmer Personality Rating Scale, differ markedly, indicating that the judges considered personality to be one of the most important factors in determining the general desirability or undesirability of the child. In total score, the median of the D group is 74 percentiles above that of the U group, and the first six of the D children all rate above the 90 percentile. Conversely, 7 of the 10 U children rank below average. Of the five divisions of the scale, the division called "Effective Energy" shows the greatest disparity between the groups. Here the median of the D group is 76 percentiles above that of the U group. The statements indicating possession of "Effective Energy" in the scale are as follows:

Skillful in body control; good coördination.
Vigorous and energetic in his attack of a project.
Sturdy, strong, robust.
Independent (considering age); self-reliant.
Adventurous; challenged by the untried.
Participates in activity.
Physically vigorous; alert; energetic.
Nearly always accomplishes task in spite of difficulties.
Voice animated, alive.
Does not become fatigued easily.

The two groups differ little in activity, as measured by the scale used. In indoor activity, the median for both groups is the 50 percentile. In outdoor activity, the D children rate somewhat higher than the U children. That this difference is not greater than it is may be attributed in part to faulty use of the measure, rather than to a true lack of distinction between the two groups in this respect.

As noted before, there is a tendency in practice to disregard the upper extremes of the five-point rating scale, though observation shows that the children do in fact indulge in the kinds of activity described in the phrases under these points. This distortion in rating may be explained by the fact that the scale is adjusted more accurately to the activity of the five-year-old than to that of the two- or three-year-old, and that when an equal number of children of two or three years of age and children of five years of age are observed, this discrepancy tends to move the actual median below the theoretical one. *Thus, while the 3d point in the scale should coincide with the 50 percentile, it coincides in practice with the 99 percentile;* and the actual median coincides with the 2d point, originally intended to describe a type of activity slightly below average. *The scale is at present being revised.*

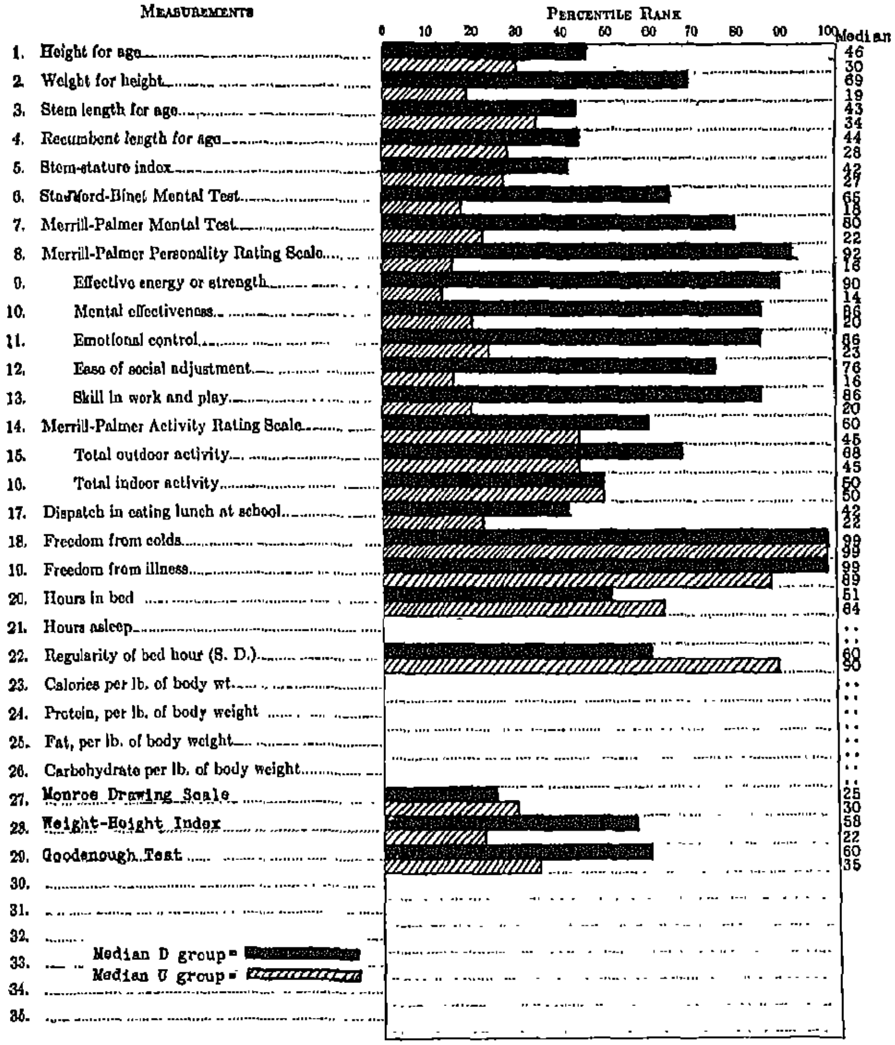


FIG. 2. MEDIAN PERCENTILES OF THE D AND U GROUPS COMPARED

In dispatch in eating lunch, the median of the D group is 20 percentiles higher than that of the U group. That the median for the U group falls in the lower quartile indicates that these children eat more slowly than do the Merrill-Palmer children of their age group, considered as a group. The five U children who fall in the lowest quartile represent distinct food problems, and it is not surprising that four of the five are underweight according to the Merrill-Palmer standards. The fifth child is a rather unhappy, introverted, day dreaming child, who, without being physically inferior, was still negative toward all the nursery school regime after three years of attendance. As has been suggested, the significance of this measurement—dispatch in eating lunch—is greater than appears at first glance. Children vary greatly in this matter. Some serve themselves with agility and neatness, have a good appetite, and do not talk or play overmuch; others, who have no appetite or have certain food dislikes, use many sorts of delay devices—mischievousness, daydreaming, frequent trips to the toilet, or regurgitation. Behavior of this sort calls for considerable skill in the student or teacher. Thus a child who is a food problem is also a behavior problem, and so might be considered undesirable even from a general point of view by the adults judging him subjectively. In addition, since a relation would be expected to obtain between appetite and body weight, and body weight is so important a factor in the general rating, the child's dispatch in eating lunch would naturally be associated (though less strongly than body weight) with the idea of general desirability. The results show this to be so.

In freedom from colds there is some slight difference in favor of the D group, but the medians for both groups are at the 99 percentile. In freedom from all illness (including colds), the median of the D group is 10 percentiles above that of the U group. In each of these standards, the basis for the percentage was the number of days for which there was a record of the child's health. The standards are based upon data for all months of the school year, and hence seasonal variation is not a factor. A study made at the School shows that colds occasioned from 39.5 per cent to 79.1 per cent of the absences of the older children, and from 39.5 per cent to 81 per cent of those of the younger group. Colds were found to be most prevalent among the older group in February; in the younger group, in February and November. They were least so among the older group in April; among the younger group, in September. In all but two of the Biograms of the present study, the data on absences were taken during one of the months between September and December. In but one case (9-U) was the child's health unfairly represented by having the record made during the month when colds were most prevalent among children of her age group.

In the number of hours in bed and the regularity of the bed hour, where the position of the optimum is controversial or may be expected to vary in individual cases, the D children tend to rank in the interquartile range—that is, to have an average amount of sleep and a fairly regular bed hour. The U children, on the contrary, tend to rank in the upper quartile in both traits, and the median of the U group is in both cases higher.

As figure 1 shows, the optimum in these traits is at present considered to be at the 50 percentile. The reasoning back of this placement of the optimum was that, for the normal, healthy child, an average amount of sleep and an average regularity of the bed hour are more desirable than the greatest possible amount or degree for the child of his age, since habits are intended to free the individual, not to hamper him. The fact that the greater number of D children were in the interquartile range may substantiate this judgment. The one child of the D group (7-D) who was in the upper quartile had albuminuria, and all four of the U children who had more than the average amount of sleep were underweight, which indicates that their parents had attempted to adjust their sleeping schedules to their health. There is an even greater disparity in the regularity of the bed hour of the two groups, the median of the U group showing a considerably greater regularity for the group than the D group has. These results do not imply, of course, that short sleeping hours or irregular bed hours are desirable for young children, or that they tend to produce desirable children; but rather, that it is desirable that the child have the amount of sleep representing the average for his age (11 hours, 45 minutes for the two-year-old; 11 hours, 30 minutes for the four-year-old), and that the bed hour vary within the average limits (24 minutes on either side of the usual time), unless the child is nervous or poorly nourished. At present there are not enough data to permit a comparison of the hours the child is in bed and the actual number of hours he sleeps.

The data on food intake are not available for the children included in the study.

Neither group shows any particular aptitude in free-hand drawing, as measured by the Monroe Drawing Scale, and there is little distinction between the two groups in this respect.

To summarize: Children of preschool age who have been designated as especially desirable by adults observing them in the nursery school tend to be average or slightly above average in weight, height, stem length, and body build; to be above average in intelligence and personality traits, especially in effective energy; to be somewhat above average in activity, especially outdoor activity; to eat their nursery school dinners in average time; and to be exceptionally free from colds and other illnesses. They have an average number of hours in bed and an average regularity in their hour of going to bed. They do not show any superiority in free-hand drawing.

Children of the same age considered relatively undesirable by the same adults present an entirely different picture. They are underweight and tend to be shorter both in total height and stem length than the superior group are, and to be shorter in limb. They are below average in intelligence and personality traits, and especially so in effective energy and ease of social adjustment. They are somewhat less active than the desirable children. They eat their dinner at the nursery school with less than average dispatch and are slightly more susceptible to colds and other illnesses than are the desirable children. On the other hand, they spend more time in bed and are more regular in their bed hour than the desirable children are; this surprising difference is due, however, not to the superiority of the homes of these children—for a subjective rating indicates that the children of group D come almost without exception from intelligent, fairly prosperous parents, while at least six of the children of group U come from homes below the average for the School economically and socially—but in part at least to the persistent educational program which goes out from the School to the home, especially in the case of thin, less healthy children. The undesirable children equal the desirable children in one trait only—drawing ability, and neither group shows particular talent in this direction. Terman (11) found the average IQ of a class of fifty children chosen from all the schools of Los Angeles for superior ability in the graphic arts to be 109, with a range of 79 to 133. This may indicate either that artistic ability does not tend to be associated with intelligence or that, as Terman suspects, and as there is considerable evidence to show, exceptional talent in painting and drawing is less likely than musical ability to appear precociously, and that these fifty subjects had little more than copying ability.

Differences between the superior and inferior children in total make-up (the Biogram as a measure of the whole child)

It appeared, however, that not only would the Biogram show group differences, but also that it could be used in individual cases as a measure of the child as an integrated organism. The study offered one means of measuring the success of the Biogram for this purpose; that is, a comparison of the child's Biogram rank, as determined by the total of his ranks in the several traits, with his rank according to the ratings of the thirty-nine judges. Before this comparison could be made, it was necessary to work out a method of totalling the Biogram from ranks in single traits. Two general methods of securing a total rank were tested. The first, consisting of a ranking of the children from high to low according to the number of optimums on their Biograms, did not show any great degree of correspondence between the ranks according to the judges and those of the Biograms. A scoring system was then worked out, as follows: A percentile rank located within the optimum range was given a score of 3. Thus, if the optimum corresponded with the interquartile range, a rank from 25 to 75 was given a score of 3; a rank from 76 to 99 was given a score of 2; and one from 1 to 24, a score of 1. If the optimum corresponded with the upper quartile, a rank from 76 to 99 was given a score of 3; a rank from 25 to 75 a score of 2; and one from 1 to 24 a score of 1. Since it was obviously unsound to assign equal rank to traits of such varying importance as intelligence and dispatch in eating lunch in adding the list, a series of weights for the various traits was the next requirement. After experiment proved several commonsense methods of weighting to be unsuccessful, an objective method, based upon the difference between the medians of the D and U groups in the various traits (fig. 2), was tried and adopted when it was found to give a higher degree of correspondence between the two rankings. On this basis, the following series of weights was worked out:

DIFFERENCE OF MEDIANS (PERCENTILE POINTS)	WEIGHT
Greater than 75	4
50–74	3
25–49	2
20–24	1
Less than 20	Trait not included in score

Of the several items of the Biogram which represent different measures of the same trait, such as the three tests of intelligence, the two measures of body length, and the two measures of body weight, the measure that discriminated best between the two groups was included and the others were omitted; and those Biogram items representing a summary of separate elements of traits, such as total personality rating (No. 8) and total activity rating (No. 14), were excluded in favor of the ratings in the separate elements.

The 10 of the 29 items of the Biogram remaining after this process of elimination and the weights assigned them by the method described were as follows:

BIOGRAM ITEM	TRAIT	WEIGHT
2	Weight for height	3
7	Merrill-Palmer test	3
9	Effective energy	4
10	Mental effectiveness	3
11	Emotional control	3
12	Ease of social adjustment	3
13	Skill in work and play	3
15	Total outdoor activity	1
17	Dispatch in eating lunch	1
22	Regularity of bed hour	2

This series of weights is interesting as showing the importance the judges attributed to the separate factors in the total physical, mental, and social make-up of the D and U children. Thus, after examination of the differences between the medians of the D and U groups (fig. 2) effective energy was given the greatest weight, and body weight with reference to height, intelligence (especially the kind measured by the Merrill-Palmer scale), and such personality factors as mental effectiveness, emotional control, ease of social adjustment, and skill in work and play were rated as of equal importance by the judges. Regularity of the bed hour is rated next, with outdoor activity and dispatch in eating lunch at the end.

The Biograms for each of the 43 children were then summarized quantitatively, according to this scoring and weighting system, and compared with the ranks given by the judges, as determined by adding algebraically the number of favorable and unfavorable votes given to each child and arranging these totals in order from the highest number of favorable votes to the highest number of unfavorable votes. The two ranks showed a correlation of $\rho = 0.82$ (Spearman Rank Difference Method). Accordingly, it may be said that a child's inherent general superiority or inferiority (relative to the group) may be determined by his total rank in the ten traits of the Biogram included in the scoring and weighting device, and by his rank in the separate traits to the extent indicated by the weights assigned to them.

Though the Biogram items not included in the scoring system, such as diet and freedom from illness, are apparently not of great importance in determining the child's essential superiority or inferiority, they are useful as a measure of traits that contribute indirectly to the child's general quality.

The small number of cases in the present study and the many data available for each child make it possible to show not only the degree of correspondence between the subjective and quantitative ratings, but also why the correlation was not higher, through an examination of what may be called the spurious cases—those in which the two ranks did not agree.

It would be expected that the ranking of the children representing the middle of the distribution would show a considerable variation in the two ranks, but that the upper ten and lower ten (the D and U groups of the study representing the rank according to the judges) would show a close correspondence. An analysis will show how far this was true.

In this analysis it must be remembered that the 10 D children represent a much closer agreement among the judges than do the 10 U children. This explains in part the fact that the Biogram ranks and the ranks according to the judges show a greater disparity at the lower end of the rankings of the 43 children than they do at the upper end.

Eight of the ten best Biogram scores correspond to the 10 D children, as ranked by the judges. According to the Biogram ranks, the other 2 children (7-D and 8-D) have positions 15 and 18, respectively. The eight spurious cases are designated as 1-S, 2-S, etc. Cases 1-S and 2-S are in the D group (7-D and 8-D respectively); cases 3-S, 4-S, and 5-S are in the U group (cases 5-U, 6-U, and 10-U, respectively); cases 6-S, 7-S, and 8-S are in neither the D group nor the U group, but according to the ranks assigned by the judges were in the middle of the distribution of the 43 cases. An examination of the qualitative records concerning the 2 children should show the reason for this disparity in the 2 ranks. The Biogram of 7-D (1-S), which gives her 15th place among the 43 children, shows that she is of average intelligence, deficient in energy, slow in eating her lunch at school, and only average in making social contacts. The qualitative description, however, shows that the child has an affable manner and is coöperative in behavior, and these qualities have outweighed in the minds of the judges (as they doubtless should) her physical deficiency, probably caused by albuminuria. (Children 7-D and 8-D actually had positions 7.5a and 7.5b, as ranked by the judges.) The Biogram of 8-D (2-S), which gives her 18th place, shows an average standing in almost all traits as measured quantitatively, except in the anthropometric traits, where she is somewhat below average Here again the qualitative description shows that the child's affability and cooperativeness have offset her defects in the minds of the judges. On the other hand, child 6-S, who had a rank of 6.5 on the Biogram, yet received favorable votes from only 7.7 per cent of the judges, evidently has some fault not measured by the Biogram which outweighed his good points in the minds of the judges, for the Biogram shows him to have the ideal rank in all traits except emotional control, skill in work and play, and intelligence (fig. 5).

TABLE 3

Ranks of the D and U children and spurious cases according to Biogram and 39 judges

CHILD	RANK IN 43	
	Biogram	Judges
1-D	2.5	1.0
2-D	6.5	2.0
3-D	2.5	3.0
4-D	5.0	4.0
5-D	1.0	5.0
6-D	4.0	6.0
7-D (1-S)	15.0	7.5
8-D (2-S)	18.0	7.5
9-D	9.0	9.0
10-D	8.0	10.0
1-U	37.5	43.0
2-U	39.0	42.0
3-U	41.5	41.0
4-U	40.0	40.0
5-U (3-S)	28.0	39.0
6-U (4-S)	29.5	38.1
7-U	33.0	37.0
8-U	37.5	36.0
9-U	41.5	35.0
10-U (5-S)	22.0	34.0
6-S	6.5	10.0
7-S	36.0	25.0
8-S	43.0	16.5

As noted before, the 10 children ranked lowest by the judges and by the Biogram show less correspondence than do the 10 children ranked highest (table 3). Seven of the 10-U children were placed in a similar position by the Biogram ranks. However, the child (8-S) who had the lowest score of the 43 on the Biogram had 12.8 per cent favorable votes; that is, about one-eighth of the judges considered him to be among the ten most desirable children in the nursery school. The Biogram showed him to have the least favored position in almost every trait—he was underweight; below average in intelligence, as measured by the Merrill-Palmer scale; was less than average in effective energy, mental effectiveness, ease of social adjustment, and skill in work and play; extremely slow in eating his school lunch; extremely irregular in his bed hour; and inactive indoors. His emotional control was above average, but not beyond the interquartile range. Again, child 7-S, who was given adverse votes by only about one-eighth of the judges, had a rank of 36 on the Biogram, where a low rank in the personality items gave him a low score.

The 3 children of the U group whose Biogram ratings did not correspond with the ratings given them by the judges ranked as follows:

CHILD	RANK IN 43	
	Biogram	Judges
5-U (3-S)	28.0	39.0
6-U (4-S)	29.5	38.1
10-U (5-S)	22.0	34.0

Child 6-U has the optimum position in weight and the next best position in effective energy, skill in work and play, dispatch in eating lunch, and regularity of bed hour. She has a rating below average in the Merrill-Palmer mental test, mental effectiveness, emotional control, and ease of social adjustment. The personality study shows her to have a certain stubbornness and lack of response to adult suggestion which, coupled with an unattractive face and dress, have doubtless served to outweigh in the minds of the judges any consideration of her good physical condition and normal activity. Child 5-U is underweight, average in all the personality factors except mental effectiveness, in which he was below average, and average in intelligence. He is above average in his dispatch in eating lunch but extremely irregular in his bed hour. His personality study shows that, while not disobedient, he was unfriendly, withdrawn, and unassertive. Child 10-U presents a similar case. She has the optimum position in body weight and a rank of 2 in all the personality items and regularity of bed hour; she has the pessimum position only in the Merrill-Palmer test and in dispatch in eating lunch. Yet here too the child's unfriendliness to adults and her uncooperative spirit have outweighed these good qualities and placed her in the U group.

In each of these eight spurious cases the qualitative data bring out certain important facts which the Biograms alone do not show. Thus they make it clear that the 3 children who were ranked higher by the judges than by the Biogram are without exception friendly to adults and cooperative, while the 5 children ranked lower by the judges than by the Biogram are somewhat unfriendly and uncooperative. It would seem logical to suppose, therefore, that these factors of friendliness and cooperation had been uppermost in the minds of the judges when they rated the children; and further, that the Biograms tended to show as high a correlation with the ranks given by the judges as they did because the five personality items were given a good deal of weight in the Biogram scoring system, and that incorporated in the 100 statements making up the personality rating scale are many which measure these factors of friendliness and cooperation. An examination of the statements, however, shows that only five of them can be said to measure this response to adults. It might be suggested, also, that even though the personality scale does not measure, as such, the "social responsiveness" of the child, the halo of attractiveness surrounding the appealing child would nevertheless tend to influence his rank on the scale. This is not borne out, however, by the personality ratings of the five spurious cases in the D and U groups—each rating representing the average of five votes. The two D children whose Biograms did not place them as high as the judges did were both in the interquartile range in personality, and of the three U children placed higher by the Biograms than by the judges, two had an average rank in total personality.

However, though the high correlation (0.82) between the rank given by the judges and that of the Biogram, representing a combination of traits, and the fact that at least one (10-D) of the D children was rated by his nursery school teacher as the most negative child under her care prove that "social responsiveness" was not the only factor in determining the judges' decisions, the clear-cut distinction between the two groups of spurious cases (those ranked higher and those ranked lower by the judges than by the Biogram) in this respect made some further consideration of the question desirable.

To determine to some degree how far the judges had been influenced by what Dr. Mark A. May (5) calls "social stimulus value," one of the nursery school teachers was asked to rank the children according to their possession of this quality. The experiment indicated that this quality had influenced the judges to some extent (or perhaps only that the superior children tend to have this trait while the others do not), for eight of the 10 children highest on her list correspond to the D children, while seven of the 10 children lowest on her list correspond to the U children. It is interesting to note that she included among the 10 highest children the boy (6-S) who had an excellent Biogram but received few favorable votes, and among the ten lowest, one of the children who had one of the worst Biograms but received a number of favorable votes. It is possible that this teacher, who is with the children every day and knows them better than the other judges, is influenced by the general quality of the children (which the Biogram should measure) even while she is considering their social stimulus value. That is, it is difficult to separate the influence of these two factors (general superiority and social stimulus value) in determining the child's rating ostensibly on the basis of one of them.

The general conclusion to be reached from a study of these spurious cases is that while the judges took into account the child's status in many of the items measured by the Biogram (some of them to a greater extent than others), they still had in mind certain additional qualities which the Biogram does not measure and which may be described as coöperativeness and social stimulus value. If the Biogram is to give a rating of the child which agrees perfectly with the opinion adults have of him, so that it can replace to a larger extent qualitative descriptions of the child in records and reports, it will be necessary to seek a measure of these two qualities. A study now under way at the School will furnish a further measure of personality factors.

One Biogram each characteristic of the D and U groups, together with one representing the spurious cases (as used here "spurious" means that the quantitative records of the children—as shown on the Biogram—and the opinion of the judges concerning them did not agree) each accompanied by a summarized qualitative description of the child follows.

I D GROUP

Child 1-D (*Fig. 3*)

Physical. Mary is a sturdy, muscular child, with fair hair, blue eyes, rosy cheeks, and a gentle, soft voice. She is pretty and feminine, but is as active and skillful on the playground as any boy. Her posture is poor, showing moderate knock-knee, markedly round shoulders, prominent abdomen, and a slight scoliosis. There are no other physical defects. The blood and urine are normal.

Mental. Mary has good motor coördination. Her language development has been excellent ever since her entrance. The quality of her imagination is shown in her play, where she invents such games as "elephant and trainer," and in the Circle, where her mimetic ability has been apparent. An instance of her superior reasoning ability is her reply when she was asked, at 32 months, whether she had a sister: "No," she said, "but Tom (her brother) has one." She has no particular aptitude for the graphic arts, but is unusually responsive to music. She has an excellent memory and shows persistence and concentration in carrying out various projects.

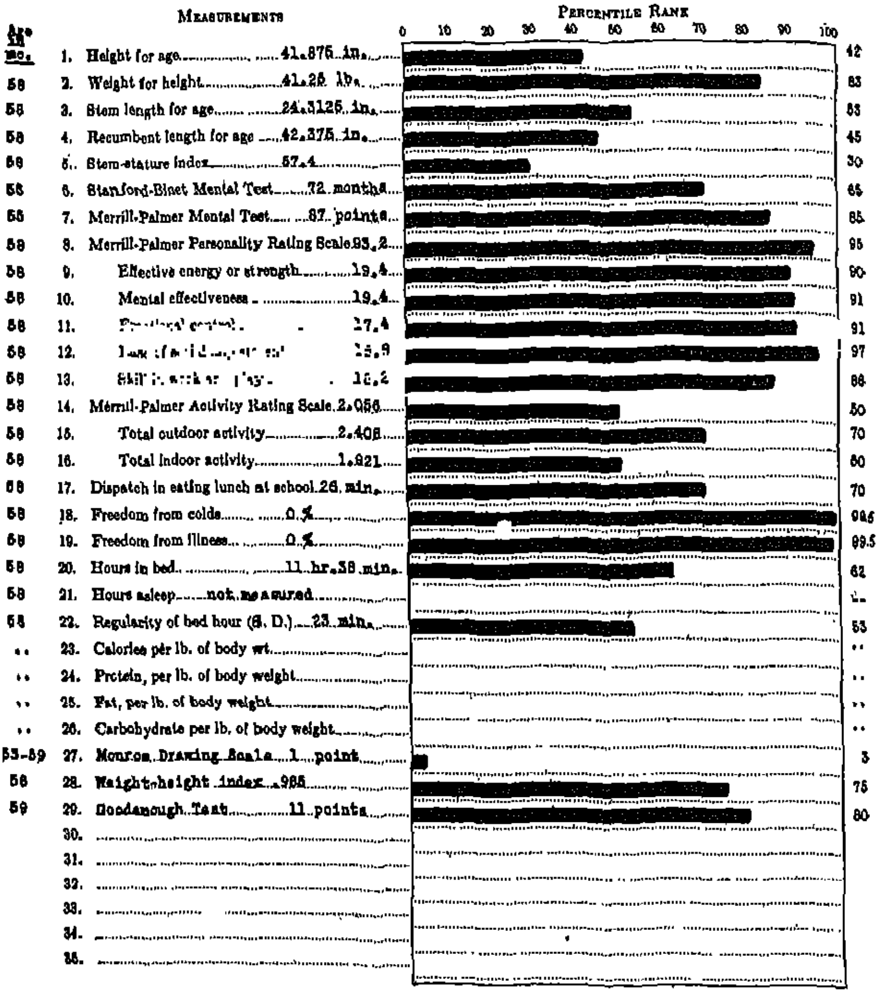


FIG. 3. BIOGRAM OF CHILD 1-D (GIRL); BIRTHDATE: 1924-3-12; AGE (MONTHS): 58; DECEMBER 28, 1928–JANUARY 27, 1929

Personality traits. Mary's mood is generally happy. Her attitude toward the teachers is undemonstrative but affectionate. Though she is a leader of both boys and girls on the playground, she usually devotes much of her attention to a single friend. She is unusually sympathetic with children who are hurt and loves to champion younger children. She is not self-centered or inclined to be jealous of the achievements of others. She seeks adult attention only when doing something worth while, and is slightly shy and self-conscious if given much attention. She responds well when spoken to and follows the nursery school regime without question. She possesses a good sense of humor.

Habits. Mary's sleep is sound and long both at night and during the nap. She eats all foods and finishes her lunch with neatness and dispatch. She is adept at dressing and washing herself.

Home environment. Mary comes from a simple, stable home, where her training has been unusually consistent and regular. The parents are of Anglo-Saxon stock. There is no history of serious physical or mental disease on either side. There is one other child, a boy 3 years older than Mary. The parents are well educated. They are affectionate but matter of fact with Mary.

Changes during three years at the nursery school. Since her entrance at 25 months of age, Mary has been an unusually well-adjusted child, considered every year, by various observers, to be the most desirable child in the school. Her personality has been essentially the same during these years. As is natural, her ability to make social contacts has steadily developed with growth. The shyness she showed at two years manifests itself, at five, in clownish behavior when she is observed too closely. She has been a healthy child, caring more for persons than things, coöperating in the school regime, concentrating well on the task at hand, and sweet-tempered and full of sympathy, though matter of fact.

II U GROUP

Child 1-U (Fig. 4)

Physical. Jane has a round baby face, light dry hair, and large brown eyes. Her body is plump, short, and stocky. Her voice is loud, whining, and shrill, and infantile in timbre. She holds her mouth wide open in smiling, disclosing both upper and lower teeth. A physical examination at 52 months showed fair development; fair posture, with slight round back and scoliosis, moderate forward head, and right shoulder high; good nutrition; and dental caries.

Mental. Jane is skillful in pasting and cutting and seems to enjoy painting and color sorting. She does not sing or respond to rhythms well. Owing to poor motor coördination, she is awkward and lumbering. She begins early in the morning to ask if it is time for her parents to come for her. She speaks slowly, with a kind of baby talk, but is easily understood; she uses short sentences. She has displayed little imagination in her play or table work, and we have few examples of her reasoning. She has not been able to concentrate well on a task, though of late she has shown some perseverance in completing paper mats and other work of this kind, mainly, however, to win the approval of the teacher. Her humor consists in the repetition of nonsense syllables, followed by loud laughter.

Personality traits. Jane's mood is invariably happy and contented. She often displays affection, rather indiscriminately throwing her arms violently around whomever she happens to be near at the time. The older children have teased her a great deal, and she sometimes evinces rage when they approach her; usually, however, she runs to an adult for protection. She is delighted if any attention is paid to her and is proud and pleased with any "work" she has done. She has shown jealousy only of other children sitting next to the teacher. She is often to be seen with a group of children who treat her like a baby. Her one constant friend is Rosalind (6-U, 4-S), who, like herself, is unable to compete socially with her chronological peers. She is easily led by others, is dependent upon the praise of adults, and accepts authority. She has no fear of strange adults, for she often approaches and talks to visitors. She is often anxious to acquire something belonging to another child and clumsily hides it in her pocket or locker to take home. Attempts to give her a sense of property rights have not succeeded. She is not always truthful.

Habits. Jane goes to sleep quietly during the nap. Her appetite is good and she is reasonably tidy about eating, though rather awkward with her fork. Her elimination is perfected. In dressing and undressing she dawdles and asks for help at every step. She is in general resistant to the nursery school regime.

Home environment. The mother is the social inferior of the father, but probably contributes more than he does to the support of the family. Both are very serious about their lives.

Changes while in the nursery school. When Jane entered the nursery school at 40 months her babyish manner was rather cunning. At that time she disliked certain foods very much; now she eats all foods heartily. She has always been very immature physically for her age. During her two years in the nursery school she has

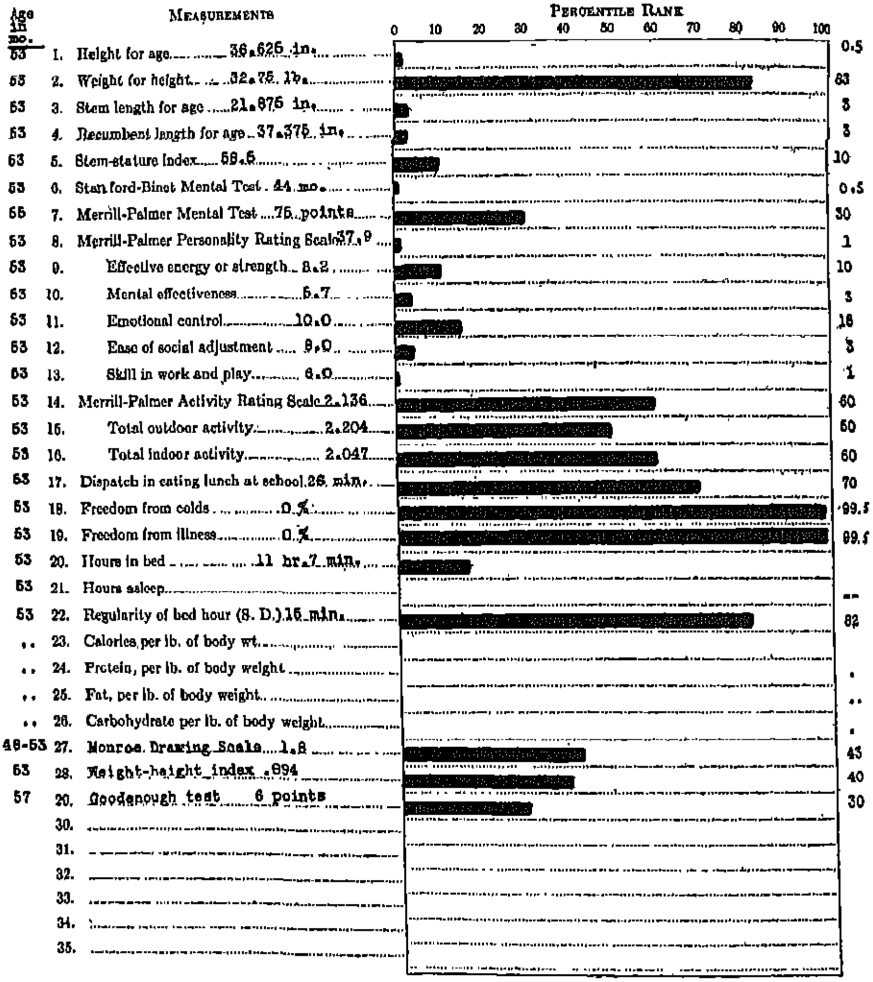
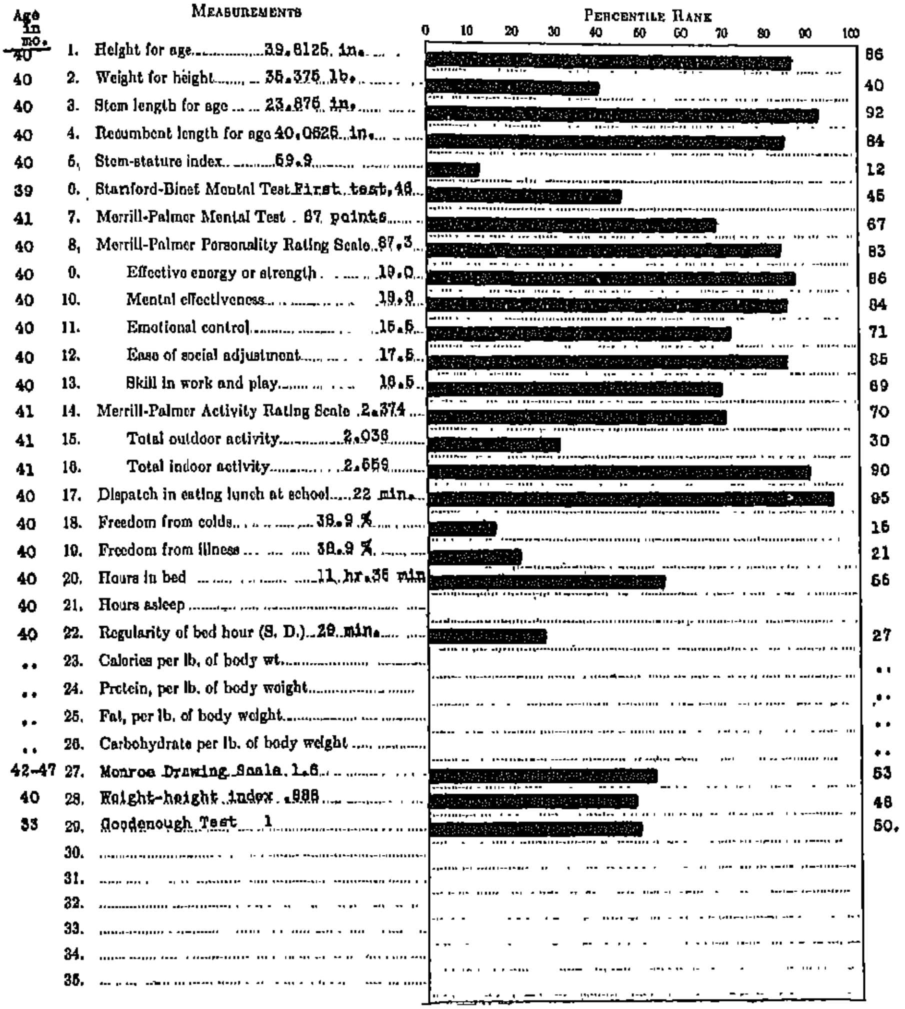


FIG. 4. BIOGRAM OF CHILD 1-U (GIRL); BIRTHDATE: 1924-5-7; AGE (MONTHS): 53; SEPTEMBER 23–OCTOBER 22, 1928

shown no improvement in adjusting to the group socially, nor has she become less selfish. On the whole she is a most discouraging prospect.



Age in mo.		MEASUREMENTS	PERCENTILE RANK
40	1.	Height for age 39.8125 in.	86
40	2.	Weight for height 35.375 lb.	40
40	3.	Stem length for age 23.875 in.	92
40	4.	Recumbent length for age 40.0625 in.	84
40	5.	Stem-stature index 59.9	12
39	6.	Stanford-Binet Mental Test First test, 46	45
41	7.	Merrill-Palmer Mental Test 67 points	67
40	8.	Merrill-Palmer Personality Rating Scale 87.3	83
40	9.	Effective energy or strength 19.0	86
40	10.	Mental effectiveness 19.8	84
40	11.	Emotional control 15.5	71
40	12.	Ease of social adjustment 17.5	85
40	13.	Skill in work and play 18.5	69
41	14.	Merrill-Palmer Activity Rating Scale 2.374	70
41	15.	Total outdoor activity 2.036	30
41	16.	Total indoor activity 2.659	90
40	17.	Dispatch in eating lunch at school 22 min.	95
40	18.	Freedom from colds 38.9 %	16
40	19.	Freedom from illness 38.9 %.	21
40	20.	Hours in bed 11 hr. 35 min	56
40	21.	Hours asleep	
40	22.	Regularity of bed hour (S. D.) 29 min.	27
..	23.	Calories per lb. of body wt.	..
..	24.	Protein, per lb. of body weight	..
..	25.	Fat, per lb. of body weight	..
..	26.	Carbohydrate per lb. of body weight	..
42-47	27.	Monroe Drawing Scale 1.6	53
40	28.	Weight-height index .898	48
33	29.	Goodenough Test 1	50.
	30.		
	31.		
	32.		
	33.		
	34.		
	35.		

FIG. 5. BIOGRAM OF CHILD 6-S (BOY); BIRTHDATE: 1925-7-18; AGE (MONTHS): 40; NOVEMBER 4-DECEMBER 3, 1928

III SPURIOUS CASES

Child 6-S (Fig. 5)

Physical. Charles is a ruddy-faced, slightly narrow-eyed child, with a noticeable twinkle and sparkle in his eye. He has a well-shaped body and head, attractive, well shaped features, and well-formed, regular teeth. He is enthusiastic in activity, attacking projects impetuously. When he is excited his voice is likely to be shrill and too loud.

Mental. Charles's greatest sensory gift seems to be his fine perception of space, shape, and size, for he handles vehicles and blocks accurately and constructively. He is often seen handling the edges of starched material, as if he enjoyed the tactual sensation. He is able to carry tunes only fairly well, but enjoys singing. He is not greatly interested in color and painting. He observes changes in the nursery school and is able to report all kinds of incidents which have happened to him away from the School. He enunciates clearly, has an excellent vocabulary, and uses fairly long sentences, but does not chatter and asks few questions. He is imaginatively constructive, as indicated by his many games of house, playing sea-lion or dog, and gas station. In one morning he dramatized being a storekeeper, a peddler selling cereal ("three for ten cents"), a man he knew, and a gas station attendant. He once built a garage with blocks and attempted to make a sliding door for it. His reasoning is excellent, as when he said of a picture of the Three Wise Men, "They are following the star," and when asked where they were following it, "To the hospital." He is very resourceful: at lunch one day when more cookies were needed at the serving table he took the plate without being told and walked to the kitchen and brought some back, though the children do not ordinarily go to the kitchen. Both in carrying out the building projects he has originated and in eating his dinner, he concentrates well; but at other times, especially when he is washing or dressing, he has continually to be watched or he runs off into another room to tease other children or the teacher. He has a childish sense of humor; he laughs at pictures of pigs, at the bathing of the bird, and so forth. He has a nervous habit of biting his nails or picking at his lips, a habit his mother says she herself has.

Personality traits. Charles is usually happy and cheerful, but he can be irritable, and though he is at times very rough with other children, he does not take buffeting from them with a good spirit. His affections are entirely normal; he does not seem emotionally dependent upon his parents or other adults, but kisses his mother goodbye willingly and often asks to be allowed to sit next to a particular nursery school teacher and is often gentle and helpful toward certain young children. On only one occasion has he shown any fear (a year after the Biogram was made), when one of the teachers remarked that he behaved as if he expected to be punished; however, he has called for a good deal of punishment for disobedience and disturbing the nap, and it would be strange if an intelligent boy of four had not learned when to expect punishment and to wince under the expectation. He is extremely belligerent—ready for a fight any minute when another child comes into his territory on the playground or interferes with him in any way—and according to a series of six weekly observations made by a student he had two fights every day. On the other hand, these temper outbursts are over quickly and he is constantly singing or laughing in pleasure over some activity he is carrying on. Though he shows no jealousy, he is distinctly antisocial where property is concerned; he wants what he wants when he wants it, and usually gets it by direct seizure. He is fond of being the leader but is so high-handed in his methods that he does not have much success in getting other children to work under his direction. Toward adults at the school he is negative, and only the teachers, who are there every day, can get coöperation from him; much of his negativism seems to be due to a desire for attention.

Habits. Charles has a splendid appetite and eats skillfully. He presents a distinct problem at naptime, for if permitted he will toss about, sit up, and make noise—anything to keep awake. He will get help in dressing if he possibly can and dawdles about washing. In general, he goes through the nursery school regime with a pugnacious spirit, either to gain attention or because he dislikes to do anything that does not suit him at the moment. In one respect he is averse to facing reality: when he does not get what he wants he pretends that it is not a desirable thing to have in any case.

Home environment. The parents are fairly prosperous. They like to have "a lot going on." They are intelligent, normal young persons. The father apparently teases his son a good deal.

Changes while in the nursery school. When Charles entered the nursery school at 2 years, 2 months of age, he was (as at present), hyperactive and impatient of any obstacle, whether a task in a mental test which he could not perform, or something he wanted which was in another's possession, or performing a duty when he preferred to be playing. He has always required constant praise if he were to continue a disagreeable task. He has developed somewhat in independence, seldom asking now for his mother when he is thwarted, though he still plays for attention in the nursery school by negativism. Though he has always been somewhat selfish, it must be said in justice that his selfishness is often followed by gentle care for a younger child. At present, a year after the making of the Biogram, Charles's qualities of leadership have improved so much that one of the nursery school teachers would place him among the ten most desirable children. In all probability child 10-D was given that place in the group, in preference to Charles, because of the difference in age. He also was negative to authority, but this quality was in a sense overridden by his leadership, while Charles, a younger child, had not yet developed his abilities in this direction, with the result that his negativism stood out as his chief characteristic.

SUMMARY

1. This study was undertaken in an attempt to test the efficiency of the Biogram, a graphic profile by means of which heterogeneous quantitative data concerning the individual child may be coordinated. At present it shows the child's ranking in 29 traits, data on which have been standardized and made comparable by means of the percentile method (14). The purpose of the Biogram is to furnish a graphic quantitative summary which will replace as far as possible the cumbersome and time-consuming qualitative summaries at present necessary in the child development centers. In its present form the Biogram is of course chiefly adapted to the records of the Merrill-Palmer School.

2. To determine what traits tended to differentiate relatively superior and inferior nursery school children, as determined by subjective choice, a comparative study was made of the Biograms of two groups of 10 children each, selected by 39 adults from among 43 children in the nursery school, the one as representing the most "desirable" children (the D group) and the other as representing the most "undesirable" children (the U group). A comparison of the percentile ranking and the median percentiles of the two groups showed considerable differences in the two groups as ranked by the Biogram. The trait that differentiated the two groups most was "effective energy," a term covering the child's rank in twenty statements representing one of five divisions of a personality rating scale. The D children were distinctly superior also in body weight, intelligence, and four personality items—mental effectiveness, emotional control, ease of social adjustment, and skill in work and play. The U children were found to have more regular bed hours than the D children; this was taken to mean that the parents of these children had adjusted their sleeping schedules to their health. The D group was superior to the U group in outdoor activity and dispatch in eating lunch. These results agree in general with those of Terman (11), who found that gifted children had general superiority, i.e., were taller, heavier, healthier, and more intelligent, than unselected

children are, and had better personality traits.

3. To determine how well the Biogram measures the quality of the "whole child," a method of totalling the Biogram ranks in single traits was worked out, and these totals were compared with the ranks given by the 39 judges. The two rankings showed a correlation of 0.82, indicating that the judges' opinions of the child's general quality and certain quantitative measurements of the child show a high degree of correspondence. It should be noted, however, that the correlation is higher than it would have been had all the quantitative measurements on the Biogram been used and given equal weight. A study of the cases in which the rank of the child on the Biogram and that given by the judges did not correspond showed that there are possibly two factors which go far toward making a child desirable in the eyes of an adult, but which are not measured by the Biogram in its present form; that is, coöperativeness (or response to authority—in this case, in the nursery school) and "social stimulus value" (5). A measure of these traits is now being constructed at the Merrill-Palmer School.

From the results of this study it may be concluded that even experts in child development are not competent to make truly objective judgments of children, and that a quantitative instrument, such as the Biogram, is needed to supplement and check their subjective judgments.

REFERENCES

(1) BOYD, EDITH: The experimental error inherent in measuring the growing human body. Oct.-Dec.,1929 American Journal of Physical Anthropology, Vol. XIII, No. 3, pp. 389–432.

(2) FRANZEN, RAYMOND: Physical measurements of growth and nutrition. 1929, School Health Research Monographs, No. II, New York: American Child Health Association, pp. xii + 138.

(3) GOODENOUGH, FLORENCE L.: *Measurement of Intelligence by Drawings.* 1926, Yonkers-on-Hudson, New York: World Book Co.

(4) HEJINIAN, LUCEA, AND HATT, ELISE: The stem-length: recumbent-length ratio as a measure of body type in young children. July–Sept., 1929, *American Journal of Physical Anthropology*, Vol. 13, No. 2, pp. 287–307.

(5) MAY, MARK A.: A comprehensive plan for measuring personality. 1930, Ninth International Congress of Psychology, *Proceedings and Papers.* Princeton, New Jersey: The Psychological Review Co.

(6) MONROE, MARION: The drawing and color preferences of young children. March, 1929. Unpublished Doctor's dissertation, The University of Chicago.

(7) ROBERTS, LYDIA J.: *Nutrition work with children.* 1927, Chicago: The University of Chicago Press, pp. xiv + 394.

(8) SIMS, V. M.: The measurement of socio-economic status. 1928, Bloomington, Illinois: The Public School Publishing Co., pp. 33.

(9) STUTSMAN, RACHEL: *Mental measurement of preschool children, with a guide for the administration of the Merrill-Palmer Scale.* Measurement and Adjustment Series, 1931, Yonkers-on-Hudson, New York: World Book Co., pp. x + 368.

(10) SWEENY, MARY E., HEJINIAN, LUCEA, AND SHOLLEY, REBECCA: A method for studying the activity of preschool children. September, 1929, *Journal of Home Economics*, Vol. 21, No. 9, pp. 671-8.

(11) TERMAN, LEWIS M., *et al.*: Genetic Studies of Genius. 1925, Vol. I, pp. xv + 648. Stanford University Press.

(12) TERMAN, LEWIS M.: The measurement of intelligence. 1916, Boston: The Houghton Mifflin Co., pp. xviii + 362.

(13) U. S. Bureau of Foreign and Domestic Commerce. *Statistical Abstract.* Washington, D. C., 1926.

(14) WILSON, CHARLES A.; SWEENY, MARY E.; STUTSMAN, RACHEL; CHESIRE, LEONEE; AND HATT, ELISE. The Merrill-Palmer standards of physical and mental growth. 1930, Detroit: The Merrill-Palmer School.

Eye and Hand Movements in the Training of Perception*

CHARLOTTE RICE

ALTHOUGH the allied fields of visual perception and manual motor coördination have been subject to no little experimentation and comment, so far as the author knows, there has been as yet no attempt to correlate the actual motor concomitants of eye and hand in an act of perception. Nor has anyone experimented with the effect the passive training of these concomitants might have on their form, and on the so-called efficiency of the perception act as it appears in the ability to reproduce or recognize the figure perceived. The experiment described in the present report, though exploratory in the extreme, and containing few, if any, positive results, is presented as a study in technique, in the hope that, as such, it may inspire someone to a further attack on the problem of the rôles played by eye and hand movements in perception.

GENERAL PROCEDURE

In brief, the method pursued was as follows. On the first morning the subjects came to the laboratory, each one was shown 4 cards, bearing the figures respectively of a diamond, a square, a circle and a triangle. The figures were black outline drawings of considerable size—the square measured 8 inches to the side, and the others were in proportion. They were shown to the subject in succession for an exposure time of 10 seconds each, and after each exposure, the child was asked to go to a large drawing easel which stood in the corner of the room, and draw the figure he had just been looking at. While the child was looking at the cards a photographic record was taken of the actual eye movements made during the time of inspection. At the same time, the subject's hands and arms were resting in the slings of a Titchener automatograph, and a record was made of the slight hand and arm movements. These two records were synchronized in a manner later to be described. This procedure was followed by an orientation discrimination test in which one of the figures—the diamond—ap-

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* This experimental work was carried out while the author was the recipient of a National Research Fellowship in Child Development at the University of California in 1929–1930.

The author wishes to take this opportunity to thank Dr. Buford Johnson of The Johns Hopkins University for the idea leading to the research, Dr. Warner Brown and Dr. Harold E. Jones for their advice and criticism throughout, and Mrs. Maye P. Mudge of the Institute staff for her assistance in obtaining the subjects.

peared in various positions and was to be discriminated from a number of other figures presented simultaneously. The final test was one of tactual discrimination in which the child was given a diamond shaped block to feel, and was asked to pick out from the board any other blocks on which it seemed to fit. The blocks were screened from the child so that he had no way of seeing what he was doing.

After the first morning, the children returned to the laboratory once a week for 4 successive weeks. The first 3 weeks were devoted to practice, and on the final week the test procedure of the initial visit was repeated to determine what effect the 3 weeks of practice might have had on the activities measured at the outset. During the practice periods members of the first eye-training experimental group were presented with a stimulus in the form of a bright yellow knob designed to move around a diamond shaped path on a black board, and were requested to keep looking at the knob all the time, and to try to move their eyes as it moved. Each trial lasted 10 seconds, and after each trial, as a tangible objective, the child was asked to turn from the board and show the experimenter by moving his finger through the air, the way the knob moved. This was repeated 3 times each practice period, and there were 3 practice periods, making 9 trials in all. At each trial, the automatograph record of the hand movements was obtained, and at the first and last trials, a photographic record of the eye movements was taken, in order to detect the amount of direct practice effect obtained in the ability to follow a moving object with the eye. The control group meanwhile was put through the same procedure with the single exception that instead of looking at the moving stimulus, the subjects looked at the original card bearing the outline figure of the diamond. This was to obviate if possible the greater familiarity with the figure of the diamond on the part of the experimental group which would occur if the control group were kept free from all such stimulation during the practice period. In this manner all conditions could be kept approximately the same with the single exception of the practice in eye movement of a defined type which was experienced by the experimental group alone.

The practice periods for the second experimental group who were given hand-training were conducted in a similar fashion. But in this case the practice consisted in following the moving knob with the hand instead of the eye. The board was screened from the subject's view, and he was instructed to grasp the knob lightly, and move his hand along with it as it moved, thus following the pattern of the diamond path with his hand instead of his eyes. The trials again lasted 10 seconds, and were followed by the same ostensible objective—tracing in the air, for the experimenter to see, the path which the hand had previously taken while following the moving knob. A record was made, in each case, of the eye movements while the hand was following the knob, to compare with the automatograph records of the hand movements of the first experimental group. It was impossible to get a graphic record of any improvement which might occur in the ability to follow the knob with the hand. The only data here available were from the notes of the experimenter in which were recorded the subjects' apparent ease in doing the task set—his tendencies to jamb the mechanism, by pushing the knob, or by pulling it out of its socket, etc. The procedure of the control group was the same as that for the controls of the first experimental group.

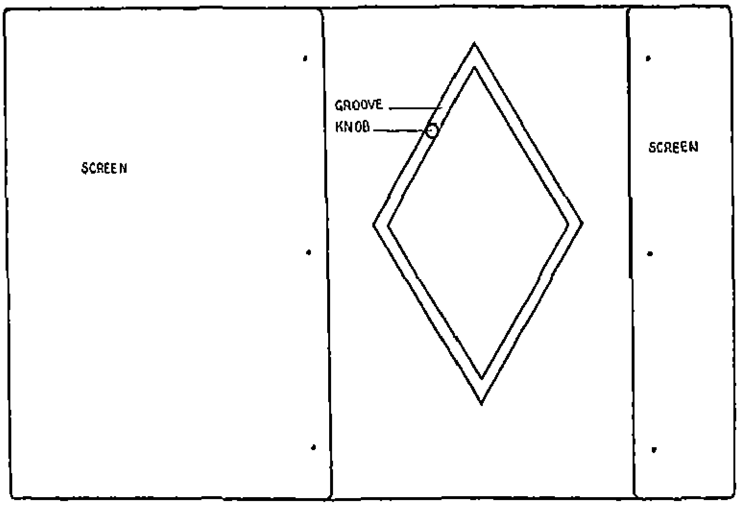

FIG. 1. STIMULUS DEVICE—SUBJECTS' VIEW

APPARATUS AND TECHNIQUE

Stimulus apparatus

As the stimulus apparatus appeared to the subject during the practice in eye movements, it consisted in a black surface, bearing, directly opposite the subject's line of gaze, a diamond outlined by a groove, around which moved a small yellow knob by means of a chain and sprocket wheel device. (See fig. 1.) Incidentally, the whole furnished a flat surface on which the stimulus cards used during the first and last days might be clipped. The subject, seated before the apparatus, looked at it through a hole in a screen. The observation hole was fitted with a head piece similar to that on the ordinary parlor stereoscope. This formed a closely fitting rim against which the head might be pressed and held practically immovable during the observation. A device for strapping the head to the head piece was devised but discarded. For the short time that the child had to look through the screen at one sitting, the directions of the experimenter together with the actual pressure of the rim served as an adequate stimulus for him to hold his head as motionless, at least, as he could be forced to do if he were strapped. The deleterious effect of the confinement would in no way be offset by any rigidity that might be gained. It is foolish to expect from a child the same freedom from head movement which might be obtained from an adult, so rather than confine the child unduly, a method was devised for recording eye movements, by which any head movements occurring might be, to some extent, compensated for. Finally, the motive power for the stimulus apparatus was furnished by a motor and speed reducer connected to the sprocket wheel of the board by a pulley belt as is indicated in figure 2.

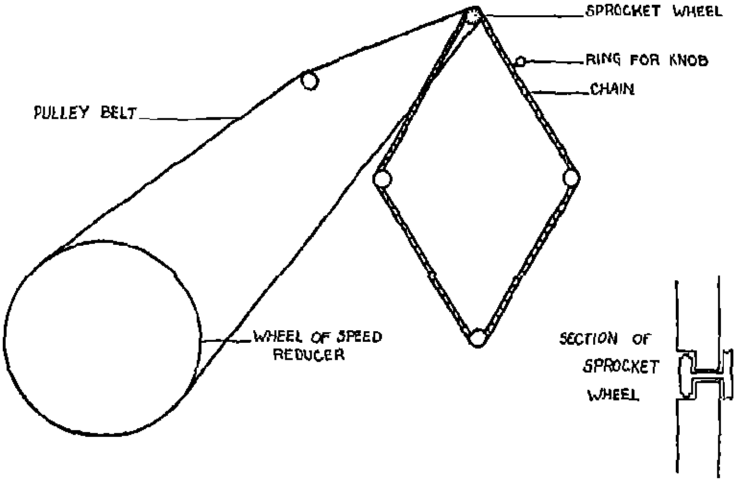

FIG. 2. STIMULUS DEVICE—MOTIVATING SET-UP

The same apparatus was used for the hand movement practice. At this time, it was simply lowered into a position where it could be easily manipulated, and the subject, instead of looking at it, looked over it to the blank wall of the room, and followed its movement with the hand.

Recording apparatus

After the carefully controlled methods of recording eye movements devised first by Dodge (1) and Judd (4) it may appear as a step backwards to use such primitive methods as those about to be described. The impossibility, however, of confining a child too closely without a serious emotional upset, and of keeping a child's attention directed toward the stimulus apparatus while at the same time a beam of light is focused directly on the eye from the side, forces one, when dealing with children, to make the situation as natural as possible. For this reason, the reflection of natural daylight streaming through a single small window, and reflected on the cornea was taken as the point to be recorded. This was photographed from about thirty degrees to the side of the direct line between the subject and the stimulus and from a distance of about two feet. Together with the light reflection from the cornea, was photographed the reflection from a bright lead bead fastened by means of a band to the center of the subject's forehead and showing distinctly through the observation hole whenever the subject looked at the stimulus object. This spot, moving as it did with the head, served as a reference point against which the spots obtained by photographing the reflection on the eye could be charted. The photographs were taken on 32 mm. film at the rate of 1 frame per second, as timed by a large seconds pendulum hanging behind the subject and in clear view of the experimenter. This speed by no means gave a complete record of the eye movements involved, but it was the highest speed practicable with the lighting conditions, and it furnished a fairly accurate picture of the general behavior of the eyes during the experiment.

In order to put the results in legible form, the photographic record was then projected on a screen, and the change in eye position from one frame to the next was recorded as carefully as possible by pricking with a pin through the exact center of the spots made by the reflection of the window on the cornea. These records were still too small for easy comparison, so the pricked card was now put into a projection machine, and the reflection thus produced was fixed on a larger card. By this process there were obtained easily legible records which could be quickly compared. Their only drawback was that they magnified any slight errors made in the first transcription.

The recording device for the hand movements consisted of 2 regular Titchener automatographs, reduced in size somewhat to be more suitable for the subjects, and with brass styluses substituted for the glass ones. In order to keep the subject's hand completely away from the stylus, a low protective partition was set against the inner side of the stylus carrier. These automatographs, suspended from the ceiling, furnished rests for both arms during the experiment. The record was taken on smoked paper under only one of the hands—the right in the case of right handed subjects, and the left in the case of left handed.

Synchronizing apparatus

There remains only to describe the manner in which the eye and hand records were synchronized so that they could be adequately compared. It has already been indicated in what manner the pictures of the eye reflection were timed. The pendulum by which this timing was accomplished was in circuit with a storage battery and the primary of an induction coil, and served as the make-break device for the whole. One terminal of the secondary coil was connected with the stylus of the automatograph, and the other with a brass plate on which the smoked paper for the automatograph record was fastened. The smoked paper acted as a spark gap, and by the insertion of a condenser in series with the secondary circuit, a sufficient spark was produced to obtain a spark record of time on the smoked paper in conjunction with the record of arm movement. A diagram of the electrical connections appears in figure 3. In this manner, theoretically, there appeared for every frame on the photographic record, a spark on the smoked paper record, so that the eye and hand movements at a particular moment might be compared for similarities or differences. Actually, the spark record sometimes failed, so the synchronization was by no means absolute, but the result was sufficiently accurate to present a general indication of correspondence or lack of it.

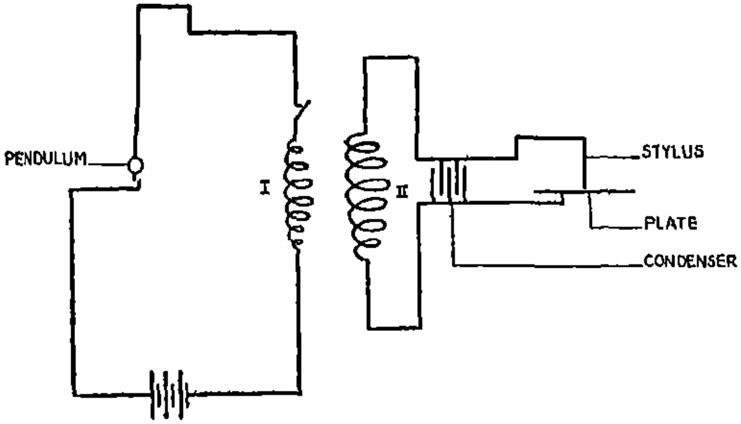

FIG. 3. ELECTRICAL SET-UP FOR SYNCHRONIZING APPARATUS

The subjects used in the experiment were ten pairs of twins which were obtained through the courtesy and effort of the Institute of Child Welfare at the University of California. The scarcity of twin pairs, from which to choose, made any choice on the basis of a home environment rating impossible. In general it may be stated that the home ratings stood slightly below the midpoint on a rating scale of 5—only two pairs receiving any ratings as high as 4, and none receiving any ratings as low as 1. A record of the ages, I.Q. ratings and similarities in physical appearance, interests and emotional traits for these subjects appears in table 1. In each case the individuals of a pair are arranged according to birth order. One of each pair was placed in the main experimental group, the other being used as its control. In the table, subjects in the experimental group are indicated by the initial letter A, while those in the control group are indicated by the letter B. The subjects were again divided according to the type of training those in the experimental group received. The first five received training in the eye movements concerned in perception, while the last five received training in hand movements. The small number of subjects was compensated for to a certain extent by the excellence of the manner of control used, and it was hoped that by a careful analysis of the results obtained on a small group like this, a method of procedure might be worked out which would be fruitful when used on a more extensive scale.

TABLE 1

Supplementary data concerning subjects

Initial letters A and B signify Training and Control Groups respectively.

SUBJECTS	RATINGS OF SIMILARITIES—SCALE OF 5				
	C.A.	I.Q.	Physical appearance	Interests	Emotional traits
		Eye training			
B 1	4:6	104	5	3	4
A 1		104			
A 2	5:3	96	2	4	3
B 2		96			
B 3	5:6	80	5	4	4
A 3		92			
B 4	5:9	93	5	5	5
A 4		89			
A 5	6:3	98	3	4	3
B 5		98			
		Hand training			
A 6	5:0	102	2	3	2
B 6		95			
A 7	5:9	90	4	4	3
B 7		103			
A 8	6:3	115	2	3	2
B 8		101			
B 9	6:7	125	3	2	2
A 9		109			
A 10	7:10	110	5	4	5
B 10		108			

METHODS OF SCORING AND ANALYSIS

It would seem that a further careful revision of the technique, and a more accurate control of all the conditions would be necessary to justify an intricate evaluation of the data obtained. So far, all that has been desired is the detection of gross differences or similarities which might direct experimentation along some more specific line, and for that reason the judgment of similarities and differences—not by any involved system of points and scales, but by the mere judgment of gross correspondences,—has been the means of evaluation of the records of eye and hand movement. In comparing a set of eye or hand movements taken before the practice period with the corresponding set taken after the practice period, one of three scores was given. If the second record was strikingly more similar to the outline of the object viewed than the first one, + was recorded. If the reverse was true, − was recorded. If there seemed to be virtually no choice, 0 was recorded. In comparing the eye movements under a certain set of conditions with the synchronized hand movements under the same conditions, the record may be interpreted as follows. If there was no possible correspondence, − was recorded. If there was obvious correspondence, + was recorded. And where the issue was in doubt 0 was recorded.

The score record for the drawing of the 4 figures during the first day's test period was a far easier proposition. Here, however, the scaling had to be much more exact. With this in mind, the following system of scoring was devised for each of the four figures independently.

Diamond

Detail considered	*Highest score*
General form:	
Scribble	0
Enclosed space—no angles or Angular line—no closure	1
Enclosed space—1 angle	2
Enclosed space—2 angles, or more than 4 angles	3
Enclosed space—3 angles	4
Enclosed space—4 angles	5
Symmetry, proportion, balance, etc.:	
Vertical angles aligned	1
Horizontal angles aligned	1
Top equal to bottom	1
Right equal to left	1
Angular relations accurate	½
Execution of lines and angles true	½
Total possible points per person.	10

Square

General form:	
Scribble	0
Enclosed space—no angles or Angular line—no closure	1
Enclosed space—1 angle	2
Enclosed space—2 angles, or more than 4 angles	3
Enclosed space—3 angles	4
Enclosed space—4 angles	5
Symmetry, proportion, balance, etc.:	
Vertical sides equal	1
Horizontal sides equal	1
One vertical equals one horizontal side	1
The other vertical and horizontal sides equal	1
All angles right angles	½
Execution of lines and angles true	½
Total possible points per person.	10

Circle

General form:	
Scribble	0
Enclosed space—no approximation to circle	1
Circle	5
Symmetry, proportion, balance. etc.:	
Top balances bottom	1
Right balances left	1
Vertical and horizontal diameters equal	2
Outline well joined	½
Execution of line true	½
Total possible points per person.	10

Triangle

General form:	
Scribble	0
Enclosed space—no angles or Angular line—no closure	1
Enclosed space—1 angle	2
Enclosed space—2 angles, or more than 2 angles	3
Enclosed space—3 angles	4
Enclosed space—3 angles, base at bottom	5
Symmetry, proportion, balance, etc.:	
Right and left symmetry	2
Equality of sides	2
Angles clearly defined	½
Execution of lines true	½
Total possible points per person.	10

By using this scoring system, and examining the data for any consistent differences between scores at different times, any effect which the practice period might or might not have had upon the execution of the forms could be determined.

The scoring of the orientation perception test was similar to a method already devised and standardized to a certain extent in a previous experiment (5). Similar changes in score could thus be noted, and their significance determined.

The test of tactual discrimination was one newly devised, and as yet, unstandardized. Performance on it was scored arbitrarily as follows:

Performance type	*Score*
All blocks chosen	0
No blocks chosen	0
One diamond block chosen	+7
Two diamond blocks chosen	+10
Triangular block chosen	−1½
Square block chosen	−1½
Circular block chosen	−7

Thus, the choice of one diamond block could be completely vitiated by the choice also of the circular block, while it would be only partially vitiated by the choice also of the triangular block. In this way an attempt was made to weight the closeness of the discrimination displayed.

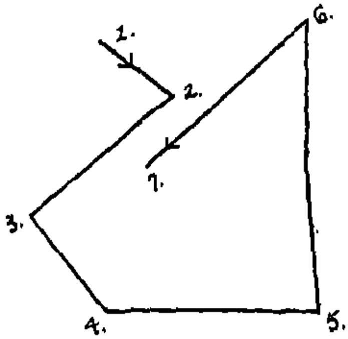

FIG. 4. PATTERN OF EYE MOVEMENT—EXAMPLE OF EXTREME CORRESPONDENCE BETWEEN EYE MOVEMENT AND FIGURE FORM

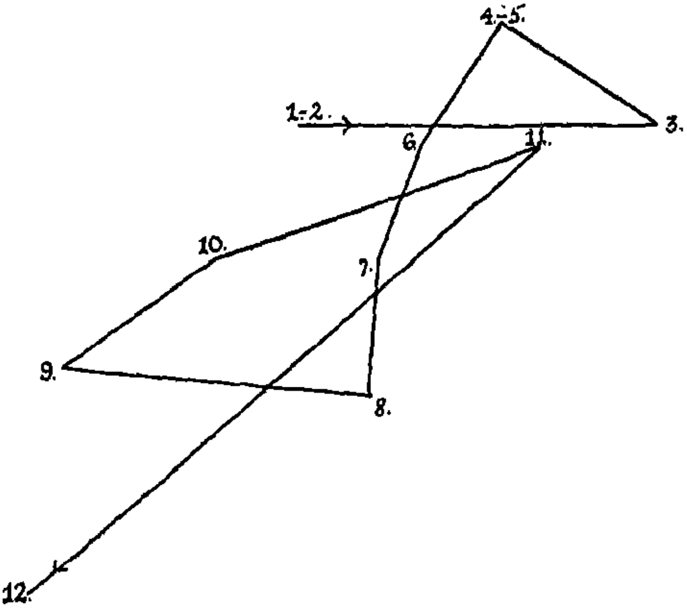

FIG. 5. PATTERN OF EYE MOVEMENT—EXAMPLE OF FAIR CORRESPONDENCE BETWEEN EYE MOVEMENT AND FIGURE FORM

RESULTS

1. First, was there any practice effect in the specific tasks practiced? In the case of eye training any such effect would be evident from an increased tendency for the record of eye movement to follow a pattern corresponding to that followed by the moving stimulus. A survey of the records

taken for the first practice of the first practice period as compared with those of the third practice of the third practice period shows that such an increase in similarity is present to a certain extent in all five subjects. In one case the record of the final practice is an extreme example of correspondence. (See fig. 4.) The other four cases, of which figure 5 is an example, combine such correspondence with the tendency to shift the eyes toward the experimenter from time to time, but in all cases, there is a distinct gain in correspondence by the last practice over the first.

For the hand training, no similar record was possible. It may simply be stated from the recorded observation of the experimenter, that in every case the manipulation of the moving knob did improve to a marked extent between the first and last practices with regard to such details as holding the knob lightly so that it would not become jambed in the groove, or so that it wouldn't be pulled from its carrying ring. In short, the subjects learned "to ride" the knob successfully within the time allotted for practice. To a considerable extent, then, the two practice procedures were hardly equivalent, for at the end of the three periods of training the pursuit movement of the eye was in most cases only partly learned, while that of the hand was completely learned. What would have happened to the results had the eye movement been more completely learned cannot even be surmised. In an attempt to keep the practice well below that which would condition the eye movement to merely looking through the screen, regardless of what was to be seen on the other side, the practice time was evidently reduced too much. But, on the other hand, the practicability of working longer with children of this age without incorporating rewards of such strength as to vitiate the results was questionable. That they were sufficiently developed physically and intellectually to succeed is obvious from the results. That they were not yet sufficiently stable emotionally to work a longer time at this rather monotonous task without some greater reward than they were getting was obvious to the experimenter from their conduct during the last practice periods. Aside from this factor, the mere bother which the parents experienced from the five weekly trips to the laboratory was not to be reckoned with too lightly. Leaving for the moment the extent to which the two movements were learned respectively, the fact remains that they were learned in part at least. And to the extent to which they were learned, the practice was effective in the specific task.

2. It remains next to be determined whether the practice was in any way effective in the related activity of looking at an outline figure of the path traced by the moving stimulus. To begin with the eye—if the practice were in any way effective in changing the way in which the eye moved during the time of regarding the outline figure of the diamond, we should expect to find consistant differences between the records of eye movements taken before the practice in eye movement, and those taken after the practice

period, characterized by a greater similarity of the latter to the outline form under consideration. Further, we should expect to find no such differences between the corresponding records made by the control group which had undergone no practice. A glance at the first column of table 2 would indicate that this difference appears surely in only one case of the five in the practice group. That it does not appear at all in the control group, and in one case actually reverses, is not enough to add the needed significance to the results of the practice group. Further, if no carry over effect is in evidence with regard to the form on which the practice occurred, it is rather needless to expect any such effect with regard to the other forms of the test. If we look at the other three columns of table 2, we find similar results to those appearing in the first column. The differences which do occur are scattered rather evenly between the practice group and the control group and nowhere show a trend consistent with an hypothesis of transfer. Finally, in the face of this, we would hardly expect to find positive results from the group subjected to the hand movement training. A glance at table 3 is convincing of the fact that the results here are as definitely negative as those in table 2.

TABLE 2

Results of comparison of eye movements before and after eye movement training

SUBJECTS	DIAMOND	SQUARE	CIRCLE	TRIANGLE
A1	0	0	0	0
B1	–	+	0	0
A2	+	0	+	0
B2	0	CL	CL	CL
A3	0	0	+	0
B3	0	0	–	0
A4	0	0	+	–
B4	0	+	+	0
A5	0	0	0	0
B5	0	0	+	0

(CL signifies that due to incomplete data the comparison is lacking.)

TABLE 3

Results of comparison of eye movements before and after hand movement training

SUBJECTS	DIAMOND	SQUARE	CIRCLE	TRIANGLE
A 6	0	0	0	0
B 6	0	0	0	0
A 7	+	0	0	0
B 7	0	0	0	0
A 8	0	0	0	0
B 8	–	0	0	0
A 9	+	0	0	0
B 9	0	0	0	CL
A10	–	+	0	0
B10	0	0	CL	–

3. The records of hand movement taken before and after the training in hand movement given in table 4 show that here again, there is no evidence of significant effects. In fact there is even less evidence of an effect here than there was for training in eye movement, in spite of the fact that the learning during the practice in hand movement was apparently more complete than that during the practice in eye movement. The difference in the results shown in the two tables

is slight and may rather be laid to a difference in the type of chance variations of the two activities than to a difference in the transfer of any practice effect. Finally, we learn from table 5 that there is no evidence that training in eye movement effects a change in the automatic hand movements during observation.

TABLE 4

Results of comparison of hand movements before and after hand movement training

SUBJECTS	DIAMOND	SQUARE	CIRCLE	TRIANGLE
A 6	0	0	0	0
B 6	CL	0	0	0
A 7	CL	0	0	0
B 7	0	0	0	0
A 8	0	0	0	0
B 8	0	0	0	0
A 9	0	0	CL	0
B 9	0	0	0	0
A10	0	0	0	0
B10	0	0	0	0

TABLE 5

Results of comparison of hand movements before and after eye movement training

SUBJECTS	DIAMOND	SQUARE	CIRCLE	TRIANGLE
A1	0	0	0	0
B1	0	0	CL	0
A2	0	+	0	0
B2	0	0	0	0
A3	+	0	0	0
B3	0	0	0	0
A4	0	0	0	0
B4	+	0	0	0
A5	0	0	0	0
B5	0	0	0	0

4. With no evidences of transfer apparent in the more closely allied activities, it would seem hardly worth while to look for any in the more remotely allied activities of drawing, orientation discrimination, and tactual discrimination. The extremely specific nature of the activities discussed so far might, however, preclude any effect on them by the particular training undergone, while such an effect would show itself in a more remotely connected, but less specific activity. Turning to the results on the drawing tests, in which the child was asked to draw from memory the figure he had just been observing, we will find them fully indicated in table 6. Inspecting the lines marked "Totals," and "II-I," we find the following facts indicated. For the subjects subjected to the eye-movement training, four out of five of the experimental group gained more points from the first to the second execution of this test than did the corresponding members of the control group. For the subjects subjected to the hand-movement training, the same was true for two out of the five. Two of these apparent gains, however,—one from each group—were in reality merely cases in which both the experimental and the control subjects had lost points from the first to the second test, and the loss by the experimental subject was somewhat less than that by the control. These data would indicate only a bare possibility of some transfer of

TABLE 6a

Results from drawing of figures—Eye trained group

	SUBJECTS																			
	A1		B1		A2		B2		A3		B3		A4		B4		A5		B5	
	Test time																			
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Diamond:																				
Form	1	4	5	1	4	4	1	4	5	3	4	1	5	5	5	5	5	5	5	5
V. angles										1		1	1	1	1	1	1	1	1	
H. angles	1	1			1	1		1			1			1				1		1
Top-Bottom														1				1		
Right-Left	1		1		1	1		1		1	1				1	1	1	1	1	1
Execution		½	½		½	½	½	½			½		½		½	½	½	½		½
Totals	3	5½	6½	1	6½	6½	1½	6½	5	5	6½	1	6½	8	7½	7½	7½	9½	7	7½
II–I	2½		−5½		0		5		0		−5½		1½		0		2		½	
Square:																				
Form	1	5	5	5	5	5	5	5	5	3	5	5	5	5	5	5	5	5	5	5
V. sides	1	1			1	1		1	1				1	1	1	1	1	1	1	
H. sides		1	1		1	1		1							1	1	1			1
V. and H. T.							1						1					1		1
V. and H. B.	1			1										1					1	
Execution	½	½	½		½	½	½	½	½				½	½	½	½	½		½	½
Totals	3½	7½	6½	6	7½	7½	6½	7½	6½	3	5	5	7½	7½	7½	7½	7½	7	7½	7½
II–I	4		−½		0		1		−3½		0		0		0		−½		0	
Circle:																				
Form	5	5	3	5	5	5	5	5	4	5	5	5	5	5	5	5	5	5	5	5
Top-Bottom		1				1	1		1	1					1	1		1	1	
Right-Left	1					1									1	1	1	1	1	
Equ. Diam.			2	1	1	2		1			2	2	1	2	2	1	2	2		2
Execution	½		½	½	½	½	½	½		½	½	½	½		1	½	½		½	½
Totals	6½	6	5½	6½	6½	9½	6½	6½	5	6½	7½	7½	6½	7	10	8½	8½	9	7½	7½
II–I	−½		1		3		0		1½		0		½		−1½		½		0	
Triangle:																				
Form	4	5	3	3	5	5	5	5	4	5	1	3	5	5	5	5	5	5	5	5
R-L sym.					2	1		2	2	1			2	2	2	1	2	2	2	2
Equal sides	2				2	1								1				2		
Execution	½	½				½	½	1					½	½	½	½	½	½	½	½
Totals	6½	5½	3	3	9	7½	5½	8	6	6	1	3	7½	8½	7½	6½	7½	9½	7½	7½
II–I	−1		0		−1½		2½		0		2		1		−1		2		0	
Total gain or loss, II–I	5		−5		1½		8½		−1½		−3½		3		−2½		4		½	

TABLE 6b

Results from drawing of figures—Hand trained group

	SUBJECTS																			
	A6		B6		A7		B7		A8		B8		A9		B9		A10		B10	
	Test time																			
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Diamond:																				
Form	4	5	0	4	5	5	5	5	5	5	5	5	5	5	5	5	3	3	5	5
V. angles		1			1	1		1	1		1	1	1	1	1	1		1	1	1
H. angles	1						1		1							1	1	1	1	1
Top-Bottom		½				1	1				1	1	1		1	1			1	
Right-Left	1	½			1			1	1	1			1	1	1				1	1
Execution	½	½			½	½	½	½	½	½	½	½	½	½	½	½	½		½	½
Totals	6½	7½	0	4	7½	7½	7½	7½	8½	6½	7½	7½	8½	7½	8½	8½	4½	5	9½	8½
II−I	1		4		0		0		−2		0		−1		0		½		−1	
Square:																				
Form	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
V. sides		1	1	1	1		1			1	1	1	1	1	1		1		1	1
H. sides		1	1	1	1	1		1		1		1	1		1	1	1	1	1	1
V. and H. T.	1		1	1				1	1		1				1					1
V. and H. B.	1		1	1		1	1		1					1	1	1				1
Execution	½	½	½	½	½	½	½	½	½	½	½	½	½	½	1	½	½	½	½	
Totals	7½	7½	9½	9½	7½	7½	7½	7½	7½	7½	7½	7½	7½	7½	10	7½	7½	6½	7½	9
II−I	0		0		0		0		0		0		0		−2½		−1		1½	
Circle:																				
Form	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Top-Bottom		1	1		1		1	1	1	1				1			1	1		
Right-Left		1	1	1	1		1	1	1	1				1	1		1	1		
Equ. Diam				1		2					2	1	2			2		2	2	2
Execution	½	½	½	½	½	½	½	½	1	½	½	½	½	½	½	½	½		½	½
Totals	5½	7½	7½	7½	7½	7½	7½	7½	8	7½	7½	6½	7½	7½	6½	7½	7½	9	7½	7½
II−I	2		0		0		0		−½		−1		0		1		1½		0	
Triangle:																				
Form	5	5	3	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
R-L sym	2	2	1	1	1	2	1	2	2	2	2	2	2	2	1	1	2	2	1	1
Equal sides		1			1	1			2	2	2	2	1		1				1	1
Execution	½	½		½	½	½	½	½	1	1		½		1	½	½	½	½	½	½
Totals	7½	8½	4	4½	7½	8½	6½	7½	10	10	9	9½	8	8	7½	6½	7½	7½	7½	7½
II−I	1		½		1		1		0		½		0		−1		0		0	
Total gain or loss, II−I	4		4½		1		1		−2½		−½		−1		−2½		1		½	

TABLE 7

Gains in score on drawing test related to I.Q. ratings

	HIGHER I.Q. GAINS	HIGHER I.Q. LOSSES
Frequency—total	2	4
Eye training	1	1
Hand training	1	3

TABLE 8

Results from orientation discrimination test

SUBJECTS	TEST TIME		
	I	II	II–I
A 1	4	3	−1
B 1	4	4	0
A 2	6	6	0
B 2	3	4	1
A 3	4	4	0
B 3	4	4	0
A 4	4	4	0
B 4	3	4	1
A 5	4	5	1
B 5	4	6	2
A 6	4	4	0
B 6	4	4	0
A 7	4	6	2
B 7	4	4	0
A 8	6	6	0
B 8	6	5	−1
A 9	4	5	1
B 9	6	6	0
A10	4	4	0
B10	4	4	0

the practice effect in the group subjected to eye training. The only other factor which would seem likely to effect the scores in this way is that of the I.Q. ratings, which it will be recalled, by reference to table 1, were not the same for the two twins of a pair in all cases. But a hasty glance at table 7 will show that if there is a relation here it is inverse. The more logical conclusion would be to assume a slight, but uncertain transfer effect.

TABLE 9

Results from tactual discrimination test

SUBJECTS	TEST TIME		
	I	II	II–I
A 1	0	3	3
B 1	0	0	0
A 2	7	0	−7
B 2	0	7	7
A 3	0	4½	4½
B 3	0	0	0
A 4	0	0	0
B 4	0	0	0
A 5	0	7	7
B 5	8½	10	1½
A 6	0	0	0
B 6	10	8½	−1½
A 7	7	10	3
B 7	8½	6½	−3
A 8	0	7	7
B 8	7	7	0
A 9	0	0	0
B 9	7	7	0
A10	7	10	3
B10	7	10	3

A survey of the results on the other two tests as they appear in tables 8 and 9, shows them to be very erratic. The scoring on these two tests was in-sufficiently standardized, and only serviceable if one wished to trace through the activities of a particular case in the records. There may be a very slight transfer effect indicated in the test of tactual discrimination. No such effect is deducible from that of orientation discrimination.

TABLE 10

Correspondence between eye and hand movements during practice periods

Practice in eye movement

SUBJECT	PERIOD	
	First period—first practice	Last period—last practice
A1	–	–
A2	–	–
A3	–	–
A4	–	0
A5	0	–

Practice in hand movement

SUBJECT	PERIOD								
	First			Second			Third		
	1st practice	2nd practice	3rd practice	1st practice	2nd practice	3rd practice	1st practice	2nd practice	3rd practice
A6	0	–	0	–	0	–	–	–	0
A7	–	–	–	CL	CL	CL	0	0	0
A8	–	–	–	0	0	–	0	0	–
A9	–	CL	0	0	0	0	0	+	–
A10	0	0	–	–	–	–	–	–	0

5. From tables 10 and 11 it may readily be gathered that any attempt to discover a carry over effect of the directed activity of the hand into the random activity of the eye, and vice versa, has again led to only negative results. Even during the practice periods (table 10) when the tension of the subject might be expected to call forth such an effect, there is almost no positive evidence of its presence. In some cases, the hand movement ceased almost entirely during the observation, but not always. More frequently the hand line was already moving in a general direction, or manner, and merely continued to do so without interruption. In any case, there appears to be almost no correspondence between the direction of its movement and that of the eyes at the same time.

6. Finally, an attempt to divide the patterns of eye and hand movements into specific types met with little success. Any types which did occur seemed dependent on the conditions of the moment rather than on a degree or type of development, and were so scattered that they were useless in determining any progressive change in type of eye or hand movement.

TABLE 11

Correspondence between eye and hand movements during observation periods

SUBJECT	FIGURE OBSERVED							
	Diamond		Square		Circle		Triangle	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
A 1	–	–	0	–	–	0	–	–
B 1	–	–	–	0	CL	–	–	–
A 2	0	–	–	–	CL	–	–	–
B 2	0	–	–	CL	–	CL	–	CL
A 3	–	–	–	0	–	–	–	–
B 3	+	–	0	–	0	–	–	–
A 4	–	–	–	0	–	0	0	–
B 4	–	–	–	0	0	–	–	–
A 5	–	0	–	0	–	+	–	–
B 5	–	–	–	–	–	–	0	–
A 6	–	–	–	0	–	–	–	–
B 6	CL	–	–	–	–	–	–	0
A 7	CL	–	–	–	–	–	0	CL
B 7	–	–	–	–	–	0	–	0
A 8	–	–	–	–	0	–	–	–
B 8	–	–	–	0	0	–	–	–
A 9	–	–	–	–	–	–	0	–
B 9	–	–	–	–	–	–	–	CL
A10	–	–	–	–	0	–	–	0
B10	–	–	–	0	–	CL	–	–

SUMMARY AND SIGNIFICANCE OF RESULTS

From these records it was hoped that some of the following facts might be obtained.

1. In the first place, a comparison of the records at the beginning with those at the end of the practice period would show any improvement in the specific ability practiced.

2. A comparison of the eye movements pursued in observing the figures on the cards before the practice period, with those pursued after, would indicate whether or not any incorporation of the learned movements had been made in the mere mechanics of observation.

3. A similar comparison of the automatic hand movements before and after practice would indicate any transfer in this direction.

4. If any observable effect of the

practice were evident under either 2 or 3, a comparison of the type, direction and extent of such effects would bear directly on the question of the relative importance of the parts played by hand and eye movements in perception.

5. Any differences present in the experimental group and absent in the control group, between the execution, before and after the practice period, of the more remotely connected tests, such as drawing of the figures, orientation discrimination, and tactual discrimination, would indicate any effect which the practice would have had upon these allied types of manual-motor coördination and perception.

6. A careful inspection of the synchronized records of hand and eye movement during any one act of observation or practice would indicate any carry over effect of the directed activity of the one into the random activity of the other.

7. Finally, if the patterns of eye and hand movements are found to divide themselves naturally into specific types, a comparison of these types with the execution of the tests made during the first and the last periods at the laboratory would indicate any progressive change in type of eye or hand movement paralleling a developmental change in perception and manual-motor coördination as measured by these tests.

Under the conditions of the experiment we have found no transfer effect of any kind from imposed practice of eye and hand movements on eye and hand movements of an unrestrained nature used during observation of plane figures. Nor have we found, from the inspection of the synchronized records of hand and eye movement during observation, or practice, any carry over effect of the directed activity of the one into the random activity of the other. We have found a definite practice effect in the specific activity undertaken during the practice periods, and a possible transfer effect of this practice on the rather indefinitely defined activity of drawing the figure observed. In the light of the very scant positive results, what is the significance of the overwhelming negative results?

Either the amount of practice was insufficient,—a fact which could be ascertained by training through a longer and more intense practice to a greater degree of learning,—or the type of training was inadequate, i.e., it was not of a type to produce such results. The experimenter is inclined toward the latter explanation. It seems to fit in with previous experiments on transfer of the practice effect of specific motor activities to those of a less specific and more highly integrated nature. Especially interesting in this connection is a comparison with the experiments of Gates and Taylor (2) and Hertzberg (3) on the motor economy factors involved in teaching beginners to write, in which they found very little carry over effect from practice on a variety of forms of tracing to the actual task of writing.

If on the other hand the results of the drawing test do show a real effect from the practice, we must limit our statement to the fact that while there is a transfer effect of some sort, it does not work through the channels of eye or hand movement, but is due rather to an increased alertness to the details of the figure during the practice period, due perhaps to the imposed motor activity, perhaps to something else, but certainly not detectable within the confines of the experimental procedure here indicated.

That some sort of eye-hand coördination is necessary for such a culmination of the perception process as the drawing of a figure from a model or from memory is self evident. That this is a relatively slow developmental process is also fairly well indicated, as well as the facts that certain people eventually are able to accomplish it better than others, and that some never do learn it adequately. An attempt has been made to ascertain just how this development takes place. It has failed. But it is hoped that the mere account of the failure may give a cue by which the problem will eventually be solved.

REFERENCES

(1) DODGE, R., AND CLINE, T. S.: The angle velocity of eye movement. Psych. Rev., 1901, 8, pp. 145–157.

(2) GATES, A. I., AND TAYLOR, G. A.: The acquisition of motor control in writing by preschool children. Teach. Col. Rec., 1923, 24, pp. 459–469.

(3) HERTZBERG, O. E.: A comparative study of different methods used in teaching beginners to write. Teach. Col. Contrib. to Educ., No. 214, 1926.

(4) JUDD, MCALLISTER AND STEELE: General introduction to a series of studies of eye movements by means of kinetoscopic photographs. Psych. Rev. Mon. Suppl., 1905, 7, No. 29.

(5) RICE, C.: The orientation of plane figures as a factor in their perception by children. Child Dev., 1930, 1, pp. 111–143.

Differential Skeletal Maturation in Relation to Sex, Race, Variability and Disease

T. WINGATE TODD

THE NEED FOR A COMPREHENSIVE VIEW OF CHILD DEVELOPMENT

IN TWO of my recent papers upon the roentgenographic study of skeletal differentiation I have described the successive stages of epiphysial maturation and union (19) and have given a quite general sketch of the phenomena checked against age as identified in the skeletons of white boys (20). So far I have left entirely untouched the problems of sex, race, local conditions of life, individual variability, correlation with other measures of development, and the devastations produced by disease. These problems are too large for adequate treatment within the limits of a single essay and I shall be content if, out of the enormous mass of data gathered during the past decade, some salient facts can be marshalled to indicate the manner in which all these problems must be viewed if we are to build a constructive interpretation of what at first appears to be a maze of conflicting observations.

It is true that we meet with different types of human form defined by a myriad of names but conveniently classified in their extreme degree as asthenic, athletic and pyknic. By whatever terms we name these and however we subdivide and classify the connecting forms, we emphasize merely superficial distinctions: there is no fundamental difference (16). Mankind in his physical growth and ultimate pattern obeys certain essential and deeply rooted laws of mammalian anatomy from which, under conditions of health and soundness of body, there is no appeal. Among these are the order and date of epiphysial differentiation and union. In recent years many loose, vague and partial observations have been recorded concerning the problem of the epiphyses by workers, honest enough, but lacking breadth of experience and understanding of the principles illustrated by the phenomena which they have tried in vain to interpret. A roentgenographic study unchecked by examination of the naked bones themselves will lead us astray (18). An interpretation of human epiphysial union uncontrolled by understanding of the mammalian pattern is like exploration of a strange city without a map to guide us (18). The assumption of a "natural" variability implies a failure to study the conditions under which divergencies from pattern are brought about. And lastly the insistence on a fundamental distinction between the sexes bespeaks a mind which still conceives man and woman as different creatures rather than manifestations of a single plan. It is not usually claimed that the actual order is different for the two sexes but that in the female there is an acceleration of increasing velocity as the years of childhood pass into those of youth. One immediately asks where, in life, this curious distinction stops. And when, under my direction, Stevenson pointed out that it could not be invoked beyond the entrance to adulthood, namely the years eighteen to twenty-two (13), numerous critics arose to expose our mistake. We made no mistake and, refraining from entering into a controversy which would leave the problem still unsettled, we have patiently continued to amass our evidence which is now ready for public examination.

THE RELATION OF SEX TO SKELETAL MATURATION

In two earlier essays I have dealt briefly with the topic of sex in relation to skeletal differentiation (15, 17) but in this review it is necessary to consider the problem a little more closely. It is stated that girls mature in their skeleton earlier than boys, at first by days, then by months, then years (10). I have no quarrel with Doctor Pryor's observations so far as they go, save that I would remind the reader, as Pryor has done, of the necessity, in this as in all observations on human growth, to check the age-records. Hospital statements of age as found on routine roentgenograms are, in our experience, frequently fallacious. In America an error of a year or two is not uncommon in children and in adults we find the error covering five to ten years. Nothing short of the birth certificate can satisfactorily establish the age record, a precaution which would be taken as a matter of course in experimental work on animals. The ill-substantiated evidence on which the tables of union in recent anatomical texts is based has already been discussed (19, 20). Dwight's account alone bears intrinsic evidence of an original investigation but that is clearly limited to the limbs excluding hand and foot (6). Epiphysial union may be set aside for the moment in favor of centers of ossification.

It has been set forth again and again, with a wealth of thoroughly substantiated evidence that ossein is precipitated in the cartilaginous skeleton of girls at an earlier age than in boys. Pryor has demonstrated it (10) and since his first observations in 1905 many observers of equal integrity and assiduity have confirmed the observation. I refer but to two of the most recent (12, 1) as examples. There is no disposition on our part to disagree. The contention is fully admitted. But at the same time one must realize that the inception of ossification in a cartilaginous epiphysis and the union of the bony epiphysis into which that cartilage is eventually transformed are two quite different phenomena, separated in most instances by many years. To insist that both must necessarily be inseparably linked phases of the same phenomenon requires a strong imagination and is devoid of proof. The date of earliest ossific penetration is itself so liable to variation from a host of causes, for the most part quite obscure, that the precise significance of the earlier appearance in the female requires much further study for its elucidation. Meantime let us not drag it into the problem of epiphysial union with which, at best it can be but remotely connected.

So far as the actual demonstrable evidence in our qualitative study of a sample thousand school children, backed by skeletal dissection, is concerned the ascertained facts are those of succeeding paragraphs.

TABLE 1

Female accelerated over male in skeletal differentiation by months as below

AGE	KNEE	HAND	ELBOW
5–0 – 5–5	6	0	0
5–6 – 5–11	6	0	0
6–0 – 6–5	6	6	0
6–6 – 6–11	12	6	0
7–0 – 7–5	15	6	0
7–6 – 7–11	12	6	0
8–0 – 8–5	9	6	15
8–6 – 8–11	12	4	9
9–0 – 9–5	6	0	6
9–6 – 9–11	18	0	6
10–0 – 10–5	18	12	24
10–6 – 10–11	24	15	24
11–0 – 11–5	18	18	18
11–6 – 11–11	12	12	12
12–0 – 12–5	12	12	9
12–6 – 12–11	6	4	24

In table 1 are drawn up the analysis of our observations upon the male and female white school children between five and thirteen years. During this period of course the estimation of age is based upon differentiation of the ossifying epiphyses and shafts.

The knee, it will be seen, maintains an ascendency in the female. While this acceleration of female over male is usually twelve months or more it drops to three times the standard deviation as worked out by Hellman (which is three months (9)) or less from five to six and a half years, about nine years and again at twelve and a half. This considerable and moderately steady female acceleration is a little difficult to interpret. However we have made a careful study of the relationship of knee differentiation to stature and find the linkage closer than with hand or elbow. We might therefore consider stature as a percentage of full adult stature, which is reached by our girls at about fifteen and a half years, rather than as a measure in absolute millimeters. The ultimate stature of the boys is far greater than that of the girls and moreover continues to rise until about seventeen years on the average. Mr. Bowman in this laboratory has shown that there is a close correlation in the adult between arm length and leg length (17) but we do not find an acceleration in elbow differentiation of the female comparable with that of the knee until after ten years. The adult female hand is small both in absolute and in relative dimensions but again there is no such acceleration in hand as there is in knee. The explanation is probably to be sought in a combination of these factors and further investigation is required.

In the table there are irregularities of relationship such as would be bound to occur in any series and are intrinsic evidence of probable reliability. The samples in general number twenty to twenty-five for each sex in each six-month period. The sudden great leap ahead of the girls in elbow maturation between twelve and a half and thirteen years is of course due to the commencement of union.

Despite all statements colored by inception of ossification, the observations of Dodge (5) show that there is increasing uniformity of bodily weight during the first eighteen months of life and the Misses Hejinian and Hatt have shown the relative stability of bodily dimension between one and five years (8). That skeletal development bears an intimate relationship to bodily growth has been demonstrated by Scammon (12). Setting on one side the equivocations of earliest ossific penetration as a phenomenon more obvious than significant, the relative uniformity of skeletal differentiation at about five years in both males and females is gradually departed from owing to progressive acceleration in the female. This sex difference increases until a general high level is reached at about eight years. There then appears a flagging in female differentiation which permits the males to catch up so that by nine years the sex difference is very small. After the tenth birthday there in another spurt of acceleration in the girls which shows distinct signs of failing before the thirteenth birthday. After this date the commencement of epiphysial union, related as it is to cessation of growth in dimensions, alters our criteria and brings us to a second phase in the study of skeletal maturation.

From thirteen years upward our standards are far less general in character than before. They are different in type and depend upon local manifestations of completion of growth. They emphasize features of the skeleton quite different from those of the preceding phase.

In table 2 are arranged the relationships of the sexes judged by these new criteria of epiphysial union. The statements are based upon the same material from which the table of epiphysial union was compiled (20). In later communications this evidence will be amplified and more completely discussed.

TABLE 2

Female epiphysial union accelerated over male by months as below

AGE	
12-6 – 12-11	18 months
13-0 – 13-5	18
13-6 – 13-11	18
14-0 – 14-5	15
14-6 – 14-11	12
15-0 – 15-5	6
15-6 – 15-11	6
16-0 – 16-5	Less than standard deviation (3 months) and thereafter the same

The standard deviation to which reference is made in table 2 is that worked out by Hellman (9). This fully accords with our own observations. Once more the reader should be reminded that the crude statement of age in years, set down without fixation by date of birth, may mean anything from one day before the ensuing birthday to six months beyond the last preceding birthday, a total range of eighteen months. In our experience individual discrepancies between exact chronological age and skeletal age differing by not more than nine months can be set aside as fluctuations due to minor causes. If however the discrepancy be twelve months or more some definite cause for the condition should be sought and will frequently be found. It may be a mistake in age record, some disease causing temporary or permanent retardation or, less often a general acceleration of development which may include mind as well as body.

In conclusion we may briefly survey the sex influence. Until the age of six years the sex differences are negligible apart from actual inception of ossification in secondary centers. From six to eight years the female forges ahead of the male and her acceleration reaches a maximum at about the latter date. There then ensues a slowing up in the female so that from the ninth to the tenth birthday the sexes are approximately equal in skeletal differentiation. After the tenth birthday the girls again undergo a period of acceleration which rapidly attains its maximum of two years and is failing when, after twelve and a half years, the criteria are changed through the introduction of a new feature, namely epiphysial union. From this date onwards the acceleration of female skeletal maturation over male diminishes until by the seventeenth birthday there is no sexual distinction which we have been able to prove to our satisfaction. In general therefore, and bearing in mind the reservations presented above, boys and girls may be said to punch the time-clock together.

THE RELATION OF RACE TO SKELETAL MATURATION

In considering the possible effect of so intangible an influence as race on skeletal differentiation it is necessary first to define what we intend by the term. Since the meaning may range from human stock to nationality we shall take one example from each of these extremes.

It has been possible to compare growth and maturation in white and American negro stocks and certain general results of our study may be briefly presented. Our negroes both male and female show much greater divergence than whites in the age-relationships of skeletal differentiation. This seems in some instances, it is true, to be an individual variability. Usually such children give a date of birth which, for a variety of reasons, we have been unable to check although others with definitely established birthdays do fluctuate a good deal in age-relationship. Most of these fluctuations however turn out on analysis to be impure. That is to say the age indicated by different skeletal areas is difficult to identify owing to obvious derangement of the area itself. Since these conflicting results trail out the age indications over a period of perhaps two or three years we term the children physical trailers. The impression one gets from studying the roentgenograms is that at some time in the child's history there has been a pathological repression of bony differentiation with definite defect in local areas. From this the child is now recovering but has not yet caught up in differentiation of certain areas to the standards for the chronological age. This is a very significant lead for further investigation. Our present feeling is that the differentiating skeleton is particularly vulnerable at certain stages of its progress. It seems likely indeed that the most vulnerable stage is that of original precipitation of bone known as commencing ossification. Thus the date of first appearance of a bony center is delayed and when it does appear the developing center exhibits a wooly or sago-like appearance which has been described by numerous terms such as Köhler's disease, Schlatter's disease and Perthes' disease. The patella, navicular of the foot and carpal bones are particularly liable to show this condition. Eventually the bony area may recover and even catch up but frequently it remains deformed permanently. The condition may involve the shaft surface also. The most widespread and severe of such lesions is Chondrodystrophia or Achondroplasia in its various degrees. Usually the damage is much more local and erratic in site. Rickets undoubtedly is one of the factors to reckon with. The lesions affect the cartilaginous skeleton but may also involve the differentiating bone. More than this we need not say at the moment.

In analysing the negro records (77 boys; 72 girls) we found that a set of standards for male negroes illustrating the average development for each age period results in the establishment of an atlas of which the criteria of progress and of age-relationship are precisely those of the male white. White and negro boys, apart from pathological conditions punch the time-clock together: there is no genuine racial distinction. It is not quite so easy to explore the progress presented in the female series. Often indeed the negro girl is in advance even of the white girls. But it is only the relatively small number of our negro girls which leaves us still hesitant in assigning differentiation of negro girls to an age relationship identical with that of the white girls. So far however we have been unable to demonstrate positively any stock-linked differences. In this our results are identical with the conclusions published by Stevenson and with the observations made on suture closure in whites and American negroes (14).

Turning now to the other extreme, namely nationality, we have certain figures from a comparative study of American and Italian children. The criterion adopted to distinguish these series was the birthplace of the parents, the birthplace of the child himself being ignored in this investigation. If both parents were born in Italy (usually south Italy or Sicily) the child was entered as Italian. If both parents were born in America, the child is American despite the location of the child's birth. All children both of whose parents were not born in Italy or America were discarded.

In these sample series we had, of American born parents 101 boys, 100 girls: of Italian born parents 175 boys, 140 girls. The ages of the children range from five to thirteen years. The finished analysis gives us the information that American boys were twelve months advanced in height over the Italians, seven months in weight and four months in skeletal differentiation.

The American girls were fifteen months ahead of the Italians in height, eight months in weight and only two months in skeletal differentiation. These differences in height and weight show a feebly progressive character so that the older children differed somewhat more than the younger. The fact that in skeletal differentiation the difference in girls was less than, and in boys scarcely more than the standard deviation indicates that there is no real distinction which can be laid to the charge of nationality.

Undoubtedly the Italians generally belong to smaller family lines than the Americans but possibly the differences in height and weight may be related to food, housing or other environmental conditions. The practical uniformity of skeletal differentiation bespeaks a uniform human pattern as do the results of our investigation of the negroes.

In skeletal development then we find no evidence of race-linked differences.

THE PROBLEM OF INDIVIDUAL DIFFERENCES AND CORRELATION WITH OTHER MEASURES OF DEVELOPMENT

The problem of individual differences, like the last topic, has two aspects. There may be inconsistencies in the child itself or the child as a unit may display a deviation from the average age-relationship. So far as the former is concerned there is nothing to be gained by further discussion at this stage. It has already been pointed out that very frequently inconsistencies of age relationship presented within the skeleton itself are due to pathological causes. One is inclined to suspect that individual divergences displayed by the child as a unit may also be due to anomalies of development. A warning has been issued against the assumption of "natural" variability which is extremely difficult to prove especially in the presence of numerous valid and tangible factors which can produce divergencies of pattern. In the period of adolescent lag, between thirteen and eighteen years, a series of fifty specially chosen lads in a health contest showed an average deviation of eight months from standard and fifty-two girls nine months from standard. There is no doubt that these candidates were selected upon widely differing standards ranging from physique to popularity and service. The incident illustrates the divergence rather than the uniformity of human material.

The most significant lead which we have struck in this phase of the problem is the fluctuation in height-weight-differentiation relationships. This has been touched upon in a previous paper but will bear further comment here. Other workers have had perforce to subdivide the children examined upon a quantitative basis and have often chosen percentiles for this purpose. The Baldwin-Wood tables for example classify the entire group, except for the highest and lowest 12.5 per cent, as medium. The remainder are designated tall and short respectively (2). This arrangement naturally and properly gives a wide range to the medium group. Upon our qualitative basis of skeletal differentiation a closer analysis can be made. A child whose skeletal record exceeds or lags behind the modal evaluation by more than nine months (three times the standard deviation) is classified as of accelerated or repressed development respectively no matter what his stature or weight.

In practice we classify as of average development all children who do not exhibit a full year's acceleration or repression. This is just as much a fiction as the other method but it permits a fuller consideration of the features of bodily development in adding a third criterion to the height-weight-age standards.

TABLE 3

303 boys; 249 girls

Percentage groupings in skeletal differentiation

	ACCELERATED	AVERAGE	REPRESSED
Boys............	9	60	31
Girls............	30	48	22

Average skeletal differentiation

	HEIGHT AND WEIGHT			
	Large line	Heavy average	Average	Small line
Boys............	33	3	37	27
Girls............	24	6	42	28

Accelerated skeletal differentiation

	ACCELERATED HEIGHT UNDERWEIGHT	ACCELERATED HEIGHT OVERWEIGHT	ACCELERATED HEIGHT WEIGHT	AVERAGE HEIGHT WEIGHT	SMALL LINE
Boys............	21	3	61	11	4
Girls............	5	4	51	24	16

Repressed skeletal differentiation

	LARGE LINE	AVERAGE HEIGHT OVERWEIGHT	AVERAGE HEIGHT WEIGHT	REPRESSED HEIGHT WEIGHT	SMALL LINE
Boys............	20	0	4	64	12
Girls............	14	5	9	49	23

In a very tentative segregation of two series of boys and girls of grade school age numbering about three hundred boys and two hundred and fifty girls we find the following information (table 3).

In boys of average development there are 37 of average height and weight. There are 33 per cent of more and 27 of less than average height and weight. These are designated large and small lines respectively. There are but 3 per cent of average height but more than average weight. These are classed as of heavy line.

Among the girls there are 42 per cent of average height and weight, 24 of large and 28 of small line respectively. The heavy averages are 6 per cent. These figures, while purely provisional are in accord with general observation.

In the group of accelerated skeletal development we find, among the boys, 61 per cent also accelerated in height and weight, 11 per cent of average dimensions, and 4 of small line. As in the average development group there are 3 per cent of overweight among the accelerated lads, but there are 21 per cent of underweight.

The figures for the girls of accelerated development are somewhat different. Fifty-one per cent are also accelerated in height and weight, 24 are of average dimensions and sixteen are of small line. There are 4 per cent of overweights and 5 of underweights. These figures again are very suggestive and are worthy of much closer scrutiny than we can give them here. No matter how they may be changed in detail by fuller investigation or amplified series the broad generalizations remain. The fewer underweight girls, the more numerous large line boys, the proportions of small line children of both sexes in average and accelerated skeletal development are all pretty much what one might have expected.

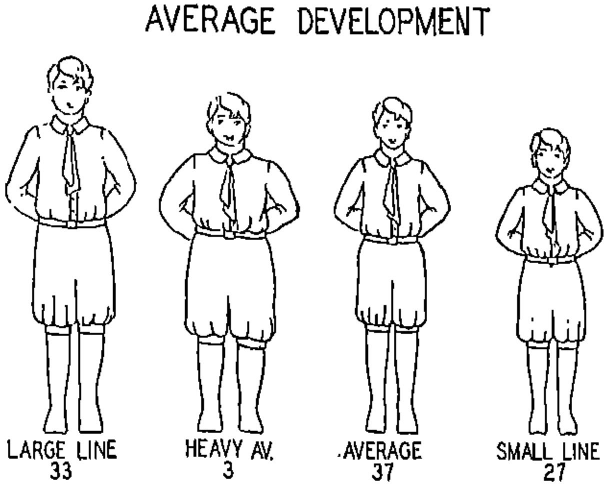

FIG. 1

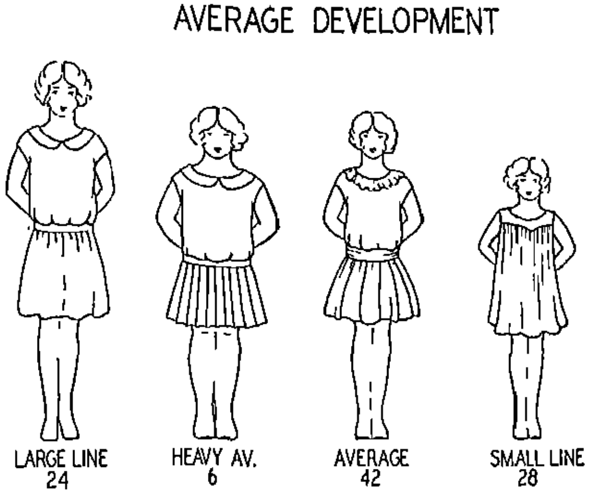

FIG. 2

FIGS. 1, 2. TENTATIVE PERCENTAGES OF VARIOUS BODILY FORMS IN WHITE BOYS AND GIRLS OF AVERAGE SKELETAL DIFFERENTIATION

Coming to the repressed groups we find 64 per cent of the boys also repressed in height and weight, 12 per cent in addition are obviously of small line and only 4 per cent are of average dimensions. There are no overweights but 20 per cent of the repressed group are of more than average height and weight. These are repressed large line lads who have the most difficult time in meeting their environment because, while they look so big, they are really younger than their age.

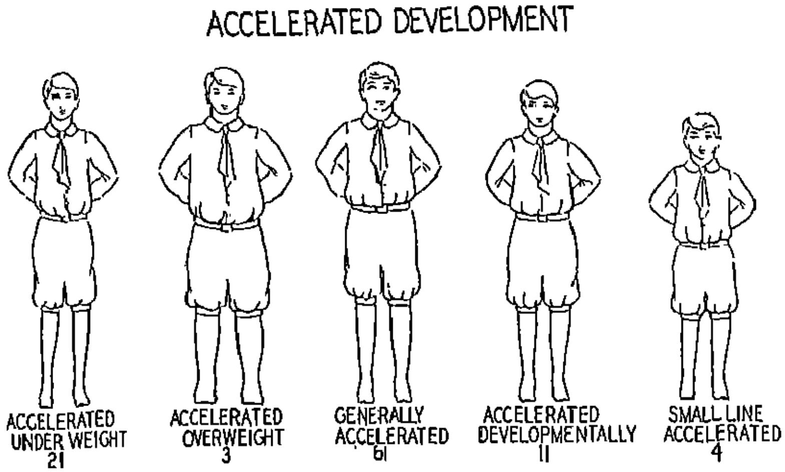

FIG. 3

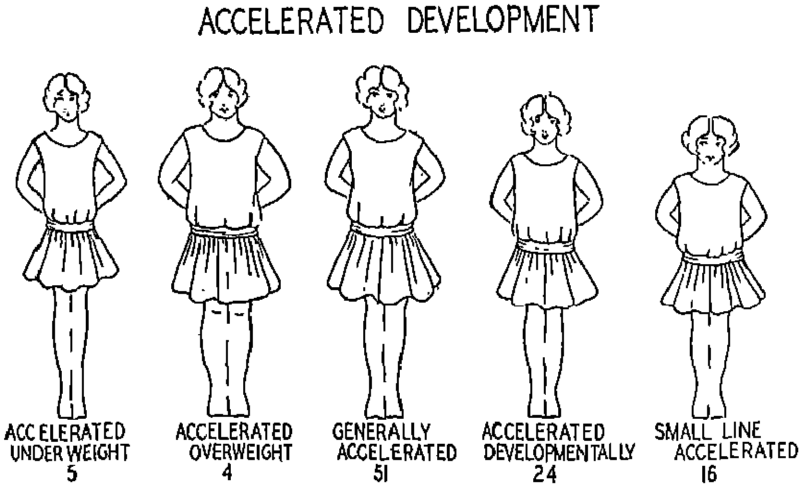
ACCELERATED DEVELOPMENT
ACCELERATED UNDER WEIGHT 5
ACCELERATED OVERWEIGHT 4
GENERALLY ACCELERATED 51
ACCELERATED DEVELOPMENTALLY 24
SMALL LINE ACCELERATED 16

FIG. 4

FIGS. 3, 4. TENTATIVE PERCENTAGES OF BODILY FORMS IN WHITE BOYS AND GIRLS OF ADVANCED OR ACCELERATED SKELETAL DIFFERENTIATION

As for the repressed girls, 49 per cent were also of less than average height and weight and 23 per cent more were distinctly of small line. There were 9 per cent of average dimensions and weight and 5 per cent of overweights. Finally 14 per cent were of large line. There is a harmony in the distribution of these figures when they are compared with those of previous groups which is quite striking.

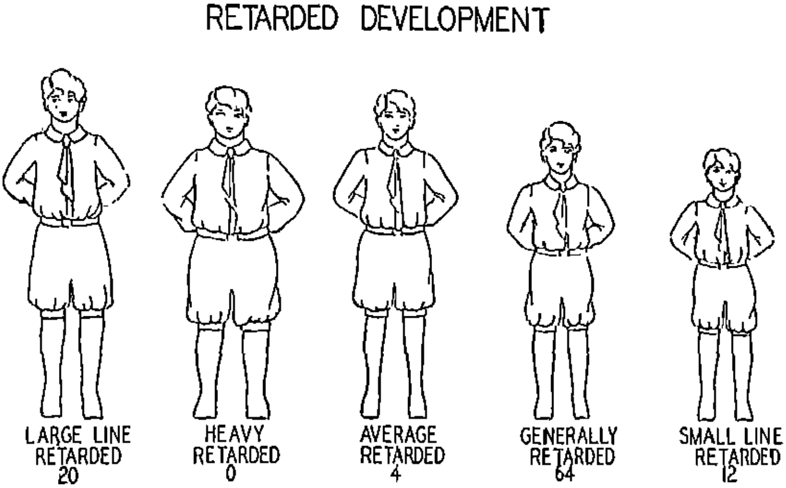

FIG. 5

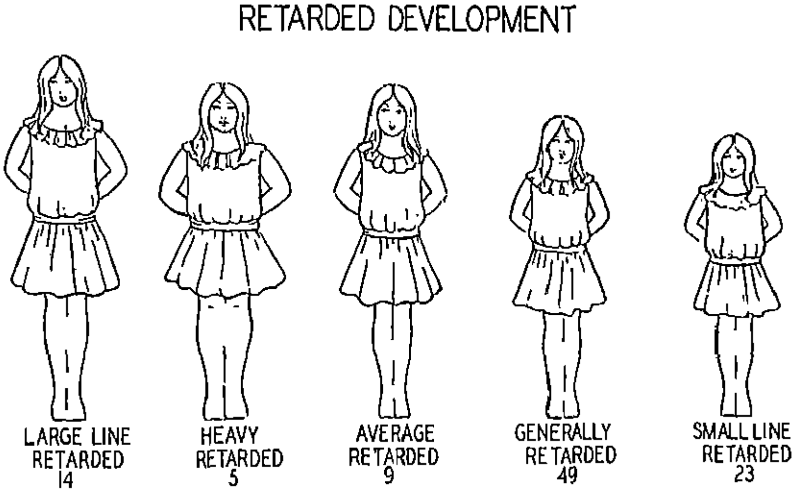

FIG. 6

FIGS. 5, 6. TENTATIVE PERCENTAGES OF BODILY FORMS IN WHITE BOYS AND GIRLS OF REPRESSED OR RETARDED SKELETAL DIFFERENTIATION

One further point must be made concerning this survey. The method of standardization, having nothing to do with height or weight, permits a hitherto unattainable freedom in segregation. Among the boys 60 per cent are of average development, nine are advanced or accelerated and 31 are repressed or retarded.

For the girls the figures are: average development 48 per cent, accelerated 30 and represesd 22 per cent. The greater variability of the girls is characteristic. The numbers in the repressed groups, large though they are and requiring close study and vigorous attention, are not so great that we should have anything but a hopeful outlook for the future.

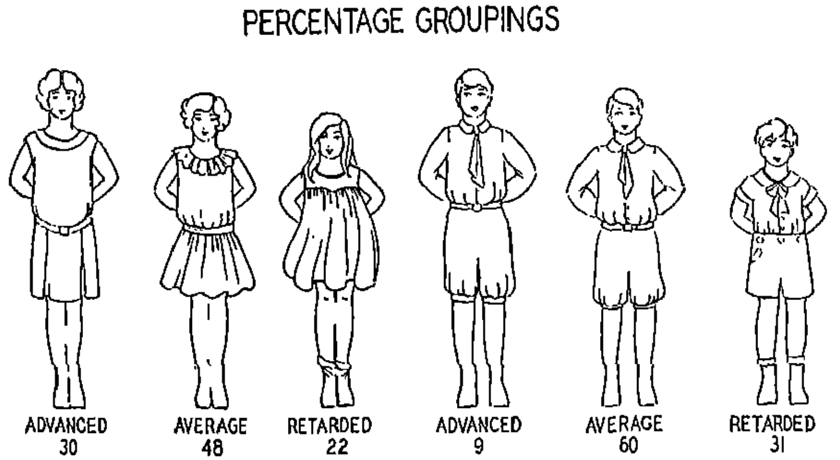

FIG. 7. Percentage Groupings of Advanced or Accelerated, Average and Repressed or Retarded Skeletal Differentiation in White Boys and Girls, Expressed Graphically in Physical Form and Facial Expression

In summing up the discussion in this chapter we may conclude that individual variability does indeed occur and that it is greater in girls than in boys. There are more accelerated girls than repressed and more repressed boys than accelerated. Consequently in general, one may get the impression that girls are as a group further advanced over the boys than is actually the case. Details are presented in the second chapter of this paper. In all groups of children there will be large average and small family lines represented. In girls there is a closer relationship between dimensions and development than in boys. This is apparent from comparison of data in table 3.

In girls the average and heavy average physiques are together in exactly the same percentage as the average skeletal development. In boys however the average and heavy average physiques are 40 per cent of the total while the individuals of average skeletal differentiation form 60 per cent of their total. Hence we have among the boys a considerable group of pure large line. Whereas their height and weight are great their skeletal development is average. They correspond to giant races in animals. In girls those accelerated in skeletal development are more numerous than those of large size. In them we have a greater number of small lines than of repressed skeletal development.

The purely provisional analysis to which the reader's attention has just been directed is reproduced as table 3.

LOCAL CONDITIONS OF LIFE

In the preceding chapter we have shown that the differences in skeletal differentiation and maturation demonstrable in any group of growing children are in large part brought about by pathological influences either in the present or past. The discrepancies which the negro children show from the white children of the same age are almost all of this type. In comparing Italian and American children we have given evidence to show that the differences are to be sought in physical form and size rather than in skeletal differentiation. It is our experience that children living under favorable home and other environmental conditions are larger than those in less fortunate circumstances. This is of course a truism. The financial status of the family has not necessarily any direct relation.

A child which is advanced in height and weight is also likely to be somewhat advanced in skeletal development especially in the knee, the differentiation of which seems more closely correlated to stature than hand or even elbow in spite of the close correlation (+0.797, see 17) in length of upper and lower limbs. Even in such fortunately placed children we do not often find the skeletal differentiation advanced more than nine months.

Again in unfavorably placed children we usually find that the repression of skeletal differentiation does not exceed nine months.

In a study of fifty undernourished children from the Cleveland Nutrition Clinic and the Fresh Air Camp we found no definite relation in the height-weight-skeletal-age records. Each of these children is a problem itself. Analysis will show exactly where the disharmony lies. Most frequently it is a disparity between height and weight rather than in skeletal differentiation.

Very undersized children may be the offspring of small family lines but there is an obscure condition which picks out one child only in a family. We have no light to offer on this problem at the moment but the observation that the knee will show greater repression than hand or elbow.

So far as can be seen at present it is unwise to postulate a "natural" variability. We ought to search far more closely into the history before we give a judgment of "natural" variation.

THE EFFECT OF DISEASE

The influence of disease upon skeletal differentiation may present itself in three definite forms.

1. Inhibition of differentiation

This may be complete as in certain hypophyseal disorders. It may however be temporary in character and the child gradually recovers. Such a condition is met with in rickets and we begin to suspect the exanthemata of affecting the skeleton in similar manner. The transverse lines or scars in the shaft of long bones recently described by Harris (7) are instances of this condition.

In Chondrodystrophia or Achondroplasia also, lesser degrees of the disease bring about a partial inhibition with derangement of the growing areas. The hypophyseal disorders are the best illustrations of this type.

One of our examples is J. W., a man of 39 years, who at autopsy showed infantile genitalia, a glabrous skin, "feminine" contours and an osteoma in his hypophyseal fossa. The skeleton presents a condition of epiphysial union characteristic of twenty years. The diaphyso-epiphysial planes are themselves intact but their surfaces are markedly pathological. The billowing has given place to an exuberant granular overgrowth of cancellous bone which is quite characteristic of such lapsed union.

A. S. a man of 35 years with the mentality of a child of about thirteen presents the same external picture. Our roentgenograms show that skeletal differentiation was inhibited at the stage characteristic of fifteen years. So far we have found no roentgenographic evidence of anomaly or osteoma in the sella turcica.

2. *Local manifestations of disorder*

These are seen in a host of conditions often identified as chronic osteochondritis. Perthes' and Köhler's "diseases" are examples. The one best worked out is the lapsed union at upper end of humerus and femur which has been described in white rats by Dawson (3) whose excellent description of the histology of the affected areas (4) is applicable to many other conditions also.

3. *More or less simple repression of skeletal differentiation from which the patient can recover under suitable treatment*

This is best exemplified by hypothyroid cases where there is not, in the juvenile stages, any insuperable pathological development in the differentiating area.

As an example of this a case examined recently may be cited. The child was a girl aged nine years. The symptoms of cretinism were not very marked but our roentgenographic records of the skeleton show a differentiation equivalent to four years. There is nothing in the roentgenograms to indicate more than a very pronounced retardation. No positive inhibition at or deformity of the shaft ends or epiphyses can be discovered. With appropriate treatment there is hope of ultimate restoration, at least in part.

The same phenomenon presents itself in the series of sheep, thyroidectomized at one month of age, received by us through the kindness of the late Professor Sutherland Simpson and Doctor H. S. Liddell. Though the data upon this series have not yet been completely arranged for publication it is worth while to use as an illustration one sheep of five years which shows in its epiphysial maturation and union and also in its eruption of teeth the condition typical of a sheep of two years and a half. Examination of the diaphyso-epiphysial areas however shows quite clearly a minor grade of the same lesion as is found in lapsed epiphysial union from other causes.

It is of course not alone in cretins and hypothyroid cases that one meets with such skeletal repressions. But these forms of disorder are very liable to develop with chronicity into examples of the first type. Such a border-line condition is illustrated by one of our negro girls of 7 years who shows a roentgenographic picture of scarred and deformed bones and epiphyses with an age equivalence of five years. Her stature, weight and muscular power are also at the five-year stage. The skeletal condition indicates healed rickets. The child has had a severe set-back from which she is now recovering and is progressing properly though still showing retardation with deformities which are permanent.

To conclude this section we may remark that pathological conditions may affect temporarily or permanently the progress of skeletal differentiation and that the lesion may be local or widespread. The skeletal picture as a rule however carries intrinsic evidence of the disorganization. The only exception, studied by us so far, is the cretin in his youthful stages before the long continued repression has become marked by definite pathological indications at the diaphyso-epiphysial planes.

SUMMARY

1. There is urgent need for a more comprehensive study of skeletal differentiation in its relation to sex, race, local conditions of life, individual variability, other measures of development and the devastations produced by disease.

2. Whether male or female the skeleton is essentially human and follows, in its development, a human pattern which is not obscured by sex modifications.

3. There is no necessary relationship between date of inception of ossification and date of epiphysial union. The undoubted earlier appearance in general of bony deposit in the cartilage of the female is not at all related to the ultimate progress of skeletal differentiation and epiphysial union.

4. The progress of skeletal differentiation presents patterns of relationship of female to male which are not uniform in the several areas of the skeleton roentgenographed. Between ten and twelve years there is a striking resemblance in the female-male relationship of the areas studied. After this the entire picture is changed by the appearance of epiphysial unions.

5. The progressive uniformity in general bodily development of boys and girls during infancy continues until six years. Skeletal differentiation is no exception, if one set aside the peculiar phenomenon of earliest ossific deposit the cause of which requires further elucidation. There then ensues a period of female acceleration reaching its maximum at about the eighth birthday and thereafter falling off so that between ninth and tenth birthdays the sexes are approximately equal in skeletal differentiation. After the tenth birthday a second period of female acceleration quickly reaches its maximum level and continues until twelve and a half years after which its diminution is measured by epiphysial union.

6. After twelve and a half years there is progressive diminution of female pre-eminence in skeletal maturation and by the seventeenth birthday when both boys and girls have reached their approximately full stat-

ure the sex differences even in epiphysial union disappear.

7. A critical study of the negro series shows these children far more liable than the whites to disorders which derange skeletal maturation. If however such examples are excluded we can find no clear evidence of a distinction in age relationship between whites and negroes.

8. Submitting a large series of children both of whose parents were born in America to close analysis of height, weight and skeletal development and checking against a similar series of children whose parents were both born in Italy, we find the Americans both taller and heavier than the Italians, age for age in six-month periods. We find no clear distinction in skeletal differentiation. From this and the previous findings we doubt very much whether there *is* any *specific relationship* of race to skeletal differentiation.

9. The age indications of the several skeletal areas in a single child may be moderately discordant. Although not frankly pathological these divergencies are usually the result of temporary disturbance in the growth pattern.

10. Just as children, by their dimensions, fall into large, medium and small family lines so they can be classified by skeletal differentiation into groups of accelerated, average and repressed development. The tentative figures submitted in this connection are worthy of careful thought.

11. Local conditions of living do affect the physical condition of the child but are reflected far more in such quantitative measurements as height and weight than in skeletal differentiation. Most instances of "natural" variation from the modal values can be assigned to definite causes and these should be sought with great care.

12. Pathological conditions may affect temporarily or permanently the progress of skeletal differentiation and the resultant lesion may be local or widespread. The skeletal picture as a *rule* however carries intrinsic evidence of the disorganization. The only exception, studied by us so far, is the cretin in his youthful stages before the long continued repression has become marked by definite pathological indications at the diaphyso-epiphysial planes.

REFERENCES

(1) BALDWIN, B. T., BUSBY, L. M., AND GARSIDE, H. V.: Anatomic growth of children. 1930 (Dated 1928), Univ. Iowa Studies, vol. 4, pp. 1–88.

(2) BALDWIN, B. T. AND WOOD, T. D.: Weight-height-age tables in English units. 1927, Iowa Child Welfare Research Station, State University of Iowa.

(3) DAWSON, A. B.: The age order of epiphyseal union in the long bones of the albino rat. 1925, Anat. Rec. vol. 31, pp. 1–17.

DAWSON, A. B.: Further studies on the epiphyses of the albino rat skeleton, with special reference to the vertebral column, ribs, sternum and girdles. 1927, Anat. Rec., vol. 34, pp. 351–363.

(4) DAWSON, A. B.: A histological study of the persisting cartilage plates in retarded or lapsed epiphyseal union in the albino rat. 1929, Anat. Rec., vol. 43, pp. 109–129.

(5) DODGE, C. T. J.: Weight of colored infants. Growth during the first

eighteen months. 1927, Amer. Jour. Phys. Anthropol., vol. 10, pp. 337–345. Weight of white infants. In Press.

(6) Dwight, T.: The skeleton. Piersol's Human Anatomy. 1911, (3rd edition) vol. 1, Philadelphia.

(7) Harris, H. A.: The growth of the long bones in childhood. 1926, Arch. Int. Med., vol. 38, pp. 785–806.

(8) Hejinian, L. M. and Hatt, E.: The stem-length: recumbent-length ratio as an index of body type in young children. 1929, Amer. Journ. Phys. Anthropol., vol. 13, pp. 287–305.

(9) Hellman, M.: Ossification of epiphysial cartilages in the hand. 1928, Amer. Journ. Phys. Anthropol., vol. 11, pp. 223–257.

(10) Pryor, J. W.: Some observations on the ossification of the bones of the hand. 1916, Bull. Univ. Kentucky, vol. 8, pp. 1–67.

Pryor, J. W.: Differences in the time of development of centres of ossification in the male and female skeleton. 1923, Anat. Rec., vol. 25, pp. 257–273.

Pryor, J. W.: Time of ossification of the bones of the hand of the male and female and union of epiphyses with the diaphyses. 1925, Amer. Journ. Phys. Anthropol., vol. 8, pp. 401–410.

Pryor, J. W.: Difference in the ossification of the male and female skeleton. 1928, Journ. Anat., vol. 62, pp. 499–506.

(11) Sawtell, R. O.: Studies in ossification and growth of children from one to eight years. 1929, Amer. Journ. Dis. Children, vol. 37, pp. 61–87.

Sawtell, R. O.: Sex differences in the bone growth of young children. 1929, Amer. Journ. Phys. Anthropol., vol. 12, pp. 293–302.

(12) Scammon, R. E.: Recent work on the physical development of children. 1927, Second Conference Child Development, National Research Council, Washington.

(13) Stevenson, P. H.: Age order of epiphyseal union in Man. 1924, Amer. Journ. Phys. Anthropol., vol. 7, pp. 53–93.

(14) Todd, T. W. and Lyon, D. W., Jr.: Suture Closure. 1924–25, Amer. Journ. Phys. Anthropol., vol. 7, pp. 325–383; vol. 8, pp. 23–45; vol. 8, pp. 47–71; vol. 8, pp. 149–168.

(15) Todd, T. W.: The anatomy of growth. 1928, Northwest Medicine, vol. 27, pp. 165–169.

(16) Todd, T. W.: Types and indices of growth in childhood. 1929, Proc. 3rd Conference Child Development, National Research Council, Washington.

(17) Todd, T. W.: Punching the time-clock of age. 1930, Proc. Interstate Post-Graduate Medical Assembly, Detroit: pp. 236–239.

(18) Todd, T. W.: Comparative youth. 1930, Child Development, vol. 1, 2, pp. 79–89.

(19) Todd, T. W.: The anatomical features of epiphysial union. 1930, Child Development, vol. 1, 3, pp. 186–194.

(20) Todd, T. W.: The roentgenographic appraisement of skeletal differentiation. 1930, Child Development, vol. 1, 4, pp. 298–310.

A Study of the Art Ability Found in Very Young Children[1]

ALMA JORDAN KNAUBER

INTEREST in the problem of better training of creative tendencies of children led to the desire to investigate experimentally the nature of art ability in very young children.

The questions arising are:

1. How early art ability appears
2. What proportion of children show art ability
3. The subject matter of interest to young children
4. The effect of stimulation on their art work
5. The quality and quantity of drawing produced

This experiment was carried on in five grades: nursery, kindergarten, first, second, and third (ages two through eight). Schools were chosen where the children had never been given any formal art instruction. The number of children included in this experiment were: 33 nursery; 20 kindergarten; 51 first grade; 12 second grade; 9 third grade.

PROCEDURE

Paper (9 x 12 inch manilla) was supplied to these various grades for a period of five weeks. Each child had access to it so that he could draw when he felt inclined and time would permit. During this period the expression was quite free and unguided. All of the drawings made were collected weekly and tabulated. After this preliminary period the experiment was carried on from three to five weeks longer. Each class was visited once a week. An art program was given by the writer. The procedure was informal and the children gathered around to watch; there was no effort made to keep them interested.

The programs were as follows:

The first week the children were asked to suggest the things which they would like to have painted, and these were then sketched for them;

The next week the writer painted a portrait of two of the kindergarten children in colonial costume;

An exhibition of original but unframed paintings was shown the children the following week;

The fourth week the beauty of flowers and flower arrangement was explained and demonstrated and a painting of flowers was made before the class;

The last week the beauty of conventional commonplace life was portrayed, such as a nicely kept yard and house, boy mowing lawn, clothes on the line blowing in the wind, etc.

The aim of this period of stimulation and exposure to art was to encourage a natural desire for self-expression by means of which they would show their ability, appreciation and interest. The drawings made by the children during this period were saved and the results tabulated. There was, then, a period of unguided expression followed by a period of stimulation. The questions to be answered concerning this experiment are:

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[1] From the School of Household Administration, The University of Cincinnati, Cincinnati, Ohio.

How many drawings did these children make?
What subjects do they draw?
How well do small children draw?
What was the effect of the stimulation?

RESULTS

1. The number of drawings made by each child is shown in table 1. The medians for the various grades show that the older the child the more prolific he was. There was also great divergence in each age, as, in the first grade some did no drawing, and others made as many as 33. Differences as great as these must mean something although there is not always a close correlation between quantity and quality.

2. The type of subject drawn varied enormously, as is shown by the fact that the children drew a total of 148 subjects. There were 68 different subjects drawn in the nursery group; 32 in the kindergarten; 79 in the first grade; 47 in the second, and 54 in the third. It would take too long to present all the subjects drawn but table 2 shows the 78 subjects drawn more than once.

3. The next step was to find out how well the children drew. To obtain this information each drawing was rated from one to ten on the basis of its merit and an average was

TABLE 1

Number of drawings made by each child in the various groups

NUMBER	NURSERY	KINDERGARTEN	FIRST GRADE	SECOND GRADE	THIRD GRADE	TOTAL	TOTAL DRAWINGS
33			1			1	33
32							
31							
30							
29							
28							
27							
26							
25							
24							
23							
22							
21		1				1	21
20			2			2	40
19			1			1	19
18	1				2	3	54
17					1	1	17
16		1	1			2	32
15							
14			1			1	14
13		1				1	13
12			3		1	4	48
11			1			1	11
10	1	1	2			4	40
9	1	1	8	3	3	16	144
8	2	1	4	1		8	64
7	2	1	5	4	1	13	91
6	3	2	6			11	66
5	2	6	6	2		16	80
4	3	1	7		1	12	48
3	2	1	1	1		5	15
2	8	1	1			10	20
1	4	1		1		6	6
0	4	1	1			6	
Pupils Total...	33	20	51	12	9	125	900
Median.	3	5	7	7	9		

TABLE 2

Objects drawn listed in order of frequency

SUBJECTS	NUMBER OF TIMES DRAWN
1. grass	404†
2. sky	294†
3. house	243†
4. tree	220†
5. flower	170†
6. sun	114†
7. water	89†
8. tent	82†
9. boat	65
10. hill	64†
11. bird	47†
12. Indian	41
13. man	33†
14. rabbit	31
15. iris	27
16. flag	25†
17. path	23†
18. boy	21†
19. fire	18*
20. girl	15
21. table	15
22. bird house	14
23. airplane	13†
24. stage	13*
25. bowl	12
26. bridge	11
27. owl	11
28. window	11
29. fence	10
30. squirrel	10
31. canoe	9
32. elephant	9†
33. Goldilocks	9
34. moon	9†
35. horse	8
36. tulip	8
37. bear	7
38. fish	7
39. fish bowl	7*
40. peacock	7
41. smoke	7
42. wagon	7
43. chair	6
44. mill	6
45. rose arbor	6
46. auto	5
47. door	5
48. floor	5
49. picture	5
50. rain	5
51. rainbow	5
52. animals	4
53. duck	4
54. eggs	4*
55. swing	4
56. valley	4*
57. balloon	3
58. clock	3
59. clouds	3
60. holly hocks	3
61. lawn mower	3*
62. mountain	3
63. road	3
64. snow	3
65. wash	3
66. big fence	2*
67. car	2*
68. cat	2*
69. Christmas tree	2*
70. cupboard	2
71. dog	2
72. garage	2
73. letters	2*
74. parachute	2*
75. steamer	2*
76. station	2*
77. train	2*

* Drawn in only one grade.

† Drawn in at least 4 of the 5 grades.

computed for each child. The same standard presented below was used for each grade:

9-10 Excellent
7-8 Good
5-6 Average
3-4 Poor
0-1-2 Failure

Table 3 shows the distribution of the resulting "quality" scores. The median for the kindergarten and first grade appeared to be the same but the first grade has a greater proportion scoring high and also the upper scores are higher. The kindergarten and first grade were stimulated by practically the same material. Those making high enough scores on this arbitrary rating scale to suggest some talent are as follows:

Nursery, 2 children out of 33
Kindergarten, 1 child out of 20
First grade, 8 children out of 51
Second grade, 1 child out of 12
Third grade, 1 child out of 9

TABLE 3

Showing average quality of work from each child

Drawings scored from 1 to 10, using same standard for each grade.

SCORE	NURSERY	KINDERGARTEN	FIRST GRADE	SECOND GRADE	THIRD GRADE
10					
9					1
8			1		
7			7	1	2
6		1	2	2	3
5		3	14	4	3
4		11	22	5	
3		2	5		
2	2	1			
1	5	1			
0	26	1			
Total....	33	20	51	12	9
Median..	0	4	4	5	6

On the average one out of 13 children appears to have at least a little artistic talent. It is recognized that the drawings in the Nursery School and to a lesser degree in the Kindergarten suffer in comparison with older children when the same rating scale is used. It may be that the more inarticulate drawings at the early ages with imaginary titles assigned to them are more predictive of later creative ability than those more representative drawings that receive a higher score. The ratings have been given in order that we may make a comparison of what the children of these ages

TABLE 4

Subjects painted for Kindergarten, and influence upon their work

TOTAL SUBJECTS PAINTED FOR CLASS	NUMBER OF TIMES PAINTED	
	Before exposure	After exposure
1. acorn....................	0	0
2. background..............	0	0
3. birds.....................	0	1
4. bowl of iris..............	0	3
5. flower arrangement*......		
6. foreground..............	0	0
7. gold fish................	0	0
8. grass....................	35	76
9. iris......................	0	3
10. leaves...................	*0*	*0*
11. portrait of boy and girl in colonial costume.......	0	0
12. rabbit....................	1	12
13. sea weed.................	0	0
14. showed water color paintings†..................		
15. shell.....................	0	0
16. squirrel..................	0	4
17. tulip.....................	0	3
18. turtle....................	0	0
19. tree......................	26	44

* No drawings returned after this lesson except one from each pupil made immediately at close of demonstration.

† Difficult to show influence statistically.

actually did in relation to standards that are assumed to be predictive of talent.

4. The last point of interest is the effect of the stimulation upon the subject matter chosen. The children added many new subjects during the week after these subjects had been drawn for them by the experimenter, although no effort was made to get them to draw these in preference to anything else. Table 4 shows a comparison of the number of times the subjects were drawn by the students before and after the experiment. The number of subjects drawn before were 17; the number of new subjects added were 15; total subjects painted were 32.

TABLE 5

Comparison of number of subjects painted before and after stimulation

	NURSERY	KINDERGARTEN	FIRST GRADE	SECOND GRADE	THIRD GRADE
Before	45	17	31	21	25
New	22	15	48	26	30
Total	67	32	79	47	55

After one of the periods the Kindergarten teacher forgot and allowed the children to take their drawings home, which probably accounts for the lack of influence shown by some of the subjects. The tabulation shows a positive influence for 7 subjects. In the short period of exposure to art one can see by table 5 that the Nursery added 22 new subjects, the Kindergarten 15, the First Grade 48, the Second Grade 26, and the Third Grade added 30. These results indicate that stimulation does influence the children and leads one to suppose that desirable forms of stimulation might leave a molding and permanent effect upon development.

The lack of ability to represent the subject accurately apparently does not concern such young artists. In the kindergarten several unique subjects were drawn or attempted. The representation of abstract and unusual subjects is common, such as "The Sky Ladder," "Sparks All Over," "Sky Man," "Sky with Stars on Bottom of It," "Bug," "Faces," "Funny Old Cloud." Of the 72 subjects drawn only once, 39 were drawn by Nursery children. The decrease in subject matter by the Kindergarten (5 years) may be due to the growth of self-consciousness and shyness and unwillingness to be satisfied with the symbols of the younger child. Somewhere in the growth between 3 and 5 years of age children apparently discover "reality" and realize that sheer imagination will not compensate for poor technique. The First Grade child has apparently achieved more confidence in his ability to represent things. He also has learned patterns from the other members of his class or from instruction, since, for instance, boats were drawn 45 times in the First Grade. In the Second and Third grades the subject matter becomes more conventional, as compared with the Nursery children. They draw houses, trees, flowers, hills, Indians, tents, etc., but none of the highly imaginative subjects of the younger child.

SUMMARY AND CONCLUSIONS

As a result of the experiment one may summarize thus:

1. The proportion of those showing talent is not more than one in thirteen.

2. There is a great difference even in two year old children as to their interest and ability to draw.

3. The subject matter of interest to the nursery children touches all the things which are new and interesting to them without regard for pattern. In the Kindergarten, First, Second and Third grade they seem to be more interested in drawing the things for which they have learned the pattern. They are apt to draw their natural surroundings as sky, tree, house, boy, girl, etc., as listed. The other subjects are those which they learn by imitating others or by being exposed to them in some way.

4. Stimulation—The stimulation was very successful in creating an interest and in developing the child's talent along natural lines.

5. It can not be concluded that one might select those with talent at this early age until more time has elapsed in which to follow the development of these children. It is suggested, however, that proper stimulation toward creative activity would produce more and better trained artists and also a people versed in the appreciation of beauty.

Brief Reports

The Relation of Nursery School Training to the Development of Certain Personality Traits*

A GROUP of 22 nursery school children tested for personality traits over a period of six months were found to have developed certain personality traits to a much greater degree than a group of 21 children without nursery school training.

The two groups of children were comparable in age, intelligence, general physical development, and in their home background. The Taussig industrial classification was used to classify the parents. The Bonham-Sargent Scale was used for the children. In this scale scores were obtained for the list of traits included in this test. It was found that the nursery school children became less inhibited, more spontaneous, and more socialized with training. They developed more initiative, independence, self-assertion, and self-reliance than the control group. They showed a greater increase of curiosity and interest in their environment. As might be expected, their habits of health and order were much more numerous than in the control group.

The superiority of the personality traits of the nursery school children over children who did not have systematic training, as shown by the statistical validity of the scores, was probably due to a great extent to the influence of the social force of a large group of children who had to adjust to each other constantly.

Average differences of the rating of personality traits of an experimental group of 22 children and a control group of 21 children as shown on the first and second Bonham-Sargent Questionnaires

(The total number of traits is much larger than the sample given here)

	EXPERIMENTAL	CONTROL
Initiative:		
Does he wait to be told what to do next?.........	−.900	+.425
Good nature:		
Is he cheerful when toys are taken away?.........	+.022	−.476
Curiosity:		
Does he ask questions demanding explanations?...	+1.040	+1.690
Does he try to open examiners' package?.......	+.840	−.150
Does he try to find out how mechanical toys operate?................	+1.630	+.047
Contentment:		
Does he play quietly with toys given him?....	+.054	+.380

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* An investigation made at the Washington Child Research Center (as graduate work for the Catholic University of America).

	EXPERIMENTAL	CONTROL
Pride:		
Does he demand praise in achievement?	−.136	+.701
Orderliness:		
Can he arrange toys in an orderly way?	+1.476	+.095
Sympathy:		
Does he show sympathy when stranger feigns weeping?	+1.289	+.047
Initiative:		
Does he climb for objects?	+.718	+.225
Habit formation:		
Has he bladder control?	+.676	+.250
Has he bowel control?	+.361	+.166
Can he feed himself?	+.529	+.300
Does he eat what is set before him?	+.718	−.025
Obedience:		
Is he obedient to parents?	+.277	+.300
Responsibleness:		
Has he a tendency to argue?	+.687	+.210
Fear:		
Is he easily frightened?	−.142	+.475
Affectionate:		
Is he affectionate?	+.055	+.105
Politeness:		
Does he say "please" and "thank you"?	−.033	+.275
Sociability and shyness:		
Does child approach other children readily?	+.684	+.550
Is he cordial to strangers?	+.368	+.263
Treatment of others:		
Is he considerate of younger children?	+.285	+.125
Miscellaneous:		
Does he exhibit responsibility for their safety?	+.333	+.076
Does he show respect for the property of others?	+.368	+.157
Does he put his toys away?	+.473	+.210
Does he keep his clothes in good condition?	+.368	+.210
Suggestibility and independence:		
Does he insist on his rights?	+.650	+.421
Does he resent interference?	+.250	+.187
Good nature:		
Is he afraid of animals?	−.100	+.050
Is he afraid of lightning?	.000	+.066
Is he afraid of darkness?	.000	+.050
Generosity:		
Will he share his favorite toys?	+.333	+.277
Will he divide a tempting delicacy with others?	+.150	.000
Pride:		
Does he react strongly to blame?	+.300	+.222
Does he react strongly to praise?	+.277	+.300
Concentration or (contentment):		
Does he turn from one activity to another?	−.352	−.052
Play habits:		
Is he self-dependent in play?	+.500	+.150
Is he noisy in play?	+.058	−.210

It can be seen that the generally accepted desirable *personality traits* increased in the experimental group and the less desirable traits increased in the control group.

MARY ELIZABETH WALSH.

Changes in Egocentricity of Nursery School Children

THE study was made to find the differences in the egocentric behavior of young children and the way the behavior changes in a new social situation. The overt behavior which showed the egocentricity of the children and the modifications were studied. Observations were made of the children during their free play activity. Egocentricity was defined *as the attempt of a child to make himself the center of an activity.*

It was found that a child expresses his egocentric behavior in three ways; by the type of play—alone or with others—by his methods of retaining toys which another child wants and by his methods of gaining attention from other children and from adults. The information was obtained by a quantitative record of the distribution of play activities. The records were kept for successive days of the children's first three months in the nursery

TABLE 1

Proportion of total time spent in various ways while at free play during different periods

CHILD	LENGTH OF TIME AFTER ENTERING SCHOOL	PLAY ALONE	PLAY WITH OTHER CHILDREN	WATCHING OR SITTING QUIETLY	WANDERING AIMLESSLY	"SOCIALIZING"
		per cent	*per cent*	*per cent*	*per cent*	
A	5 weeks	51.7± 5.3	35.0± 4.9	1 ± .7	9.3 ±0.7	3 ±2.0
	9 weeks	62.5± 9.4	33.5± 3.0	1 ± .7	3.0 ±2.0	0 ± ?
	11 weeks	66.7± 5.2	17.0± 8.1	1 ± .7	12.7 ±1.2	3 ±2.0
	Change between 5th week and *11th week*	+15.0± 3.6	−18.0± 5.9	0 ± .4	+3.0 ±3.5	0 ±1.8
B	5 weeks	64.0± 6.2	10.3± 5.5	16.7± 9.9	4.7 ±0.3	5.0 ±1.0
	9 weeks	35.5± 8.9	20.5±13.8	2.5± 1.7	10.5 ±7.1	31.0 ±3.4
	11 weeks	60.7±10.1	36.7± 5.0	0 ± ?	0 ± ?	2.7 ±1.8
	Change between 5th week and 11th week	−3.3±10.1	+26.4± 5.0	−16.7± 6.3	−4.7 ±0.2	−2.3 ±1.3
C	5 weeks	16.7± 7.7	46.7±14.8	10.7± 7.2	16.7 ±3.3	10.7 ±4.6
	9 weeks	18.5± 3.7	54.5± 9.3	1.5± 1.0	8.5 ±0.3	17.5 ±3.7
	11 weeks	22.3± 9.1	35.0± 8.8	17.3± 5.1	13.75±3.5	11.75±4.6
	Change between 5th week and 11th week	+5.6± 8.2	−11.7±10.6	+6.5± 5.5	−3.0 ±3.1	+1.0 ±4.4
D	5 weeks	41.3±18.8	0 ± ?	47.0±10.6	7.0 ±2.7	0 ± ?
	9 weeks	12.5± 2.4	24.0±11.5	31.5±16.6	21.5 ±9.6	9.5 ±6.4
	11 weeks	20.0± 8.6	48.0±11.2	10.0± 6.0	8.0 ±5.4	8.0 ±2.9
	Change between 5th week and 11th week	−21.3±11.2	+48.0± 7.8	−31.0±10.7	+1.0 ±4.0	+8.0 ±2.0

school. Quantitative frequency records were kept also of the attempts to prevent another child from taking a toy, of the amount of time spent voluntarily near adults, of aggression towards other children, of the amount of crying and the number of temper tantrums.

It was found that those children who were dominantly egocentric on entrance into a new social situation make few significant changes during the first three months, but the unaggressive children become more egocentric in their play, changing from the unaggressive to the aggressive. A positive correlation was obtained between the age of the child on entering a new social situation and the type of egocentricity.

L. F. Ezekiel.

The Space Order Reaction of Young Children

TWO tests devised by Schachne Isaacs for the study of the development of the space order reaction required in reading were given to 23 children in the Child Institute of The Johns Hopkins University. The ages ranged from two and one-half to five and one-half years.

POINTING AT PICTURES

Two sets of sixteen colored pictures, of varying degrees of interest, familiarity, and attractiveness, were mounted in rows of four on charts, 20 x 20 inches, ruled off in 5 inch squares. These were presented to the child who was given a yard stick and asked to point to and name as quickly as he could all the pictures on the chart. The examiner recorded on a prepared form the order of naming, noting repetitions and omissions.

In the first set of pictures one child used the reading order in pointing, one used another regular order, and 21 used no regular order. In the second set the same child used the reading order as she did in the first set, and two used another regular order. Twenty used no regular order.

CHECKING CIRCLES

The child was asked to put a check in each circle of a set of 16 half-inch circles, $\frac{1}{2}$ inch apart, in rows of four. A similar record of order of checking, repetitions and omissions, was made.

In this test none used the reading order, two used other orderly methods, and seven gave a semi-orderly response, that is, twelve or more of the checks were arranged in an orderly manner. Fourteen used no regular order.

For speed and accuracy the most effective response is to begin in one of the four corners and name or check across rows or up and down columns. A number of adults tested gave without exception the reading order of response.

These results indicate that the reading space order from left to right which is used by adults in responses to the situations of the test procedure is determined by training in reading.

Roberta White.

Influence of Suggestibility on Responses in Ink Spot Test

SUBJECTS of this experiment were 16 children, 11 boys and 5 girls, from the Child Institute of Johns Hopkins. Their age was recorded to the nearest month and mental age computed from the I.Q.:

	Median	*Range*
C.A.	53 mo.	65–41 mo.
M.A.	58.5 mo.	89–45 mo.
I.Q.	114.5 mo.	83–137

Materials consisted of ink spot plates number 1 to 10 from Whipple's series.

PROCEDURE

Series A

After the child was seated at a small table the experimenter said, "I am going to show you a funny shaped spot." The first plate was placed on the table in front of the child with the directions, "You tell me what it looks like." A stop watch was used to record the time from exposure of the picture to the first response. If the child said that the picture did not look like anything he was urged to "just pretend" what it looked like.

Series B

This was given a week or two after series A. Procedure was identical except that when the ink spot was shown, in addition to saying, "Tell me what it looks like," the question was added, "Is it a girl?" for spot 1, "Is it a policeman?" for spot 2, etc. The words suggested for the various spots were as follows:

1. girl
2. policeman
3. hat
4. flower
5. elephant
6. doctor
7. rabbit
8. table
9. squirrel
10. snake

RESULTS

The time of reaction was not significant. It was slightly less on the average for series B where suggestion was given, but the difference was very small.

A. The responses were tabulated for each ink spot separately. Those used most often were:

Spot 1. man (4 times) horse (2 times)
2. lady (7) man (3) woman (2)
3. dog (10)
4. house (2)
5. dog (3)
6. lady (4) king (2) house (2)
7. lady (4)
8. chair (2) man (2)
9. chair (2) foot (2)
10. tree (3) bear (2) man (2)

In all 73 different responses were made, with a total of 168 when repetitions were counted. Of this total 43 per cent were names of animals, 30 per cent of people, and 27 per cent of objects. In choosing the names which were suggested in series B, this proportion was adhered to. Four names of animals were used, three of people, and three of objects. Five of these names had appeared once in the children's responses of series A, five not at all. In no case was a name suggested in connection with the spot to which it had been applied in series A.

Series B was scored on the bases of the number of suggestions which were accepted. Acceptance meant saying "Yes" or repeating the name suggested. If a child said "No," but then named the spot in accordance with the suggestion given, this was scored acceptance. If he said "Yes," but then gave some other name, it was scored rejection of the suggestion.

The acceptance score ranged from 0 to 9 with an average of 3.3.

Two of the children applied the same name to several of the spots. The youngest child used only three different names for the ten ink spots, the oldest used nine, and two used ten. The average number of different names used was 7.9.

A record was also made of the number of times each child called a spot by the same name in series B which he had applied to it in series A. This number ranged from 0 to 8 with an average of 2.5.

REVISED PROCEDURE

The change in procedure involved the giving of a suggestion with the first instead of the second series, a change in some of the suggestion words, and the use of a better presentation of the spots.

The subjects of this experiment were 20 children, 13 boys and 7 girls attending the Nursery School of the University of Minnesota. Their age was recorded to the nearest month at the time of commencing the experiment. The I. Q. was taken from a test given previously, the Kuhlman-Binet in the case of 12 children, Minnesota Test in the case of 8. Mental Age was calculated from the I. Q. to the nearest month.

	Median	*Range*
C.A.	47 mo.	37–60 mo.
M.A.	50 mo.	31–79 mo.
I.Q.	108.5 mo.	83–152

Apparatus consisted of the first ten ink spot plates of Whipple's series of twenty, and a simple exposure frame. This was a large envelope of black paper with an opening 2½ inches square through which the plates were shown. Two small chairs and a low table to which the frame was tacked completed the set-up.

Series A

The experimenter and the child both seated themselves at the table. The envelope was lying before the child with plain black paper showing through the aperture. Light came from above and to the left of the child. When the child was at ease his attention was directed to the envelope and then the first plate was exposed. The question was asked: "What does this look like, a girl?" If the child did not respond he was encouraged by the words, "What?" or, "Tell me what it looks like." After the child's response had been recorded the first spot was removed, exposing the second. The above procedure was repeated except that a different object was suggested as a name for the ink spot. The objects suggested for the 10 spots were:

1. girl
2. dog
3. bird
4. engine
5. engine
6. tree
7. rabbit
8. table
9. squirrel
10. boat

Series B

The materials and procedure were identical with those used in series A except that the suggestion was omitted. When a picture was exposed the child was asked, "What does this look like?" After the child's response assent or approval was shown by saying, "Yes," or repeating the word the child had given so as to make sure of it.

Series B was given approximately three weeks after series A. With nine of the children the interval was 20 days, with seven, 21 days, with two, 22 days, with one, 24 days, and with one, 26 days. All of the tests of this experiment were given between the hours of 10:00 and 12:00 a.m.

Results

The children reacted to the test situation in a variety of ways. Some seemed very anxious to please, accepting the suggestion given by the experimenter because they thought they were supposed to do so. Others paid scarcely any attention to what the experimenter said, brushing aside the names offered and enjoying the task of using their own imaginations. A few were not interested in the task and accepted the suggestions because that was the easiest and quickest way to get through. One boy insisted on manipulating the pictures himself, removing each after he had named it. The test seems to be at fault in its lack of opportunity for the child to *do* anything.

In three cases a child failed to accept a suggestion merely because he had already named the spot before time was given for the suggestion. This time element is important and should be more carefully controlled.

In series B the most obliging children had a tendency to repeat one name after the experimenter had approved it, applying it to several succeeding ink spots. A few of the older children recognized the ink spots as what they had seen in Series A but the majority made no such comment.

Tabulation of the various types of reaction gave the following figures:

Series A

	Spots
Suggestion accepted for	116
Suggestion first accepted then rejected for	8
Suggestion first rejected then accepted for	3
Delayed acceptance of suggestion for	10

This last includes those cases where the suggested name was rejected, but then applied to the next ink spot. The first category alone contains enough cases to make scoring possible and this was adopted as the score measuring receptivity for suggestion. It ranged from 10 in four cases to 0 in two. The average score was 5.8.

Series B

	Spots
Suggestions given in series A retained for	13
Names applied in series A repeated for	41
Name applied which was both a repetition of the suggestion and a repetition of the name used in series A	8

The fact that 116 out of a possible 200 suggestions were accepted seems to indicate that it was easier for a child to accept than to reject suggestions under the test conditions. Delayed acceptance of suggestion appeared definitely in only four cases. The other six cases are made up of those who called spot 3 a "dog." Since this spot in reality closely resembles a pup, that fact rather than the suggested name dog for the previous spot probably caused the delayed suggestion.

In series B there were 41 cases where a child repeated the same name which he had given to a spot previously. Of these only 8 were names suggested by the experimenter. Memory for suggested names is thus much poorer than memory for those names which the child applied to a spot himself.

Those children who accepted the most suggestions in series A seem to accept no more than the average in series B. The children were divided into two groups according to their score in series A. The sum of the scores of the ten highest was 87, of the ten lowest 29. Yet in series B the upper ten accepted only 6 suggestions, while the lower accepted 7.

Though there appears to be no correlation between acceptance of suggestions in series A and using that suggestion again in series B, there is a significant negative correlation between receptivity score (series A) and repeating in series B the name used in series A. By the rank order method the coefficient of correlation was −.57 with a P.E. of .11. This may be explained by the fact that memory is related to general intelligence which in turn seems to have a negative correlation with suggestibility or receptivity. The coefficient correlating I.Q. and receptivity score is −.40, P.E. .13. Score correlates slightly lower with C.A., −.37, P.E. .13, and highest with M.A., −.47, P.E. .11. This is in agreement with other investigations which find suggestibility correlated inversely with intelligence.

Roberta White.

A General Information Test for Kindergarten Children[1, 2]

CATHRYN A. PROBST

IN SPITE of the growing interest in the study of child development, up to the present time but few research workers have concerned themselves with the amount and types of knowledge possessed by the young child before he begins his elementary school education. Since the fundamentals of general information are acquired early, and since later instruction must be founded upon the store of knowledge previously gained by the child, some means of measuring his informational level is needed.

SURVEY OF PREVIOUS INVESTIGATIONS

In 1891 Hall (1) published the results obtained by submitting 200 five and six year old children in the Boston schools to an information test which included 49 items, having to do with such matters as parts of the body, simple geometrical forms, home and family life, familiar objects, etc. The most outstanding finding of the study was the amazing ignorance of the children regarding many of the concepts with which they were assumed to be thoroughly acquainted. Sex differences both in amount and kind of information were also found: the boys exceeded the girls in knowledge of 34 of the 49 items, but the girls were superior to the boys in knowledge of parts of the body, home and family life and similar widely diffused concepts; while the boys excelled in knowledge of the sphere, cube, pyramid, numbers, animals and other more specialized matters less common to all environments.

In addition to his own findings, Hall also reports those of several other writers. Lange found that in the city schools of Plauen only 43 per cent had seen the nearest castle. In color discrimination, black, white and red were better known colors than were green and blue, while yellow was the least familiar. Higher percentages were attained by the boys in identifying all of the seventeen subjects included in the test except that the girls rated higher in knowledge of the "dear God."

In a study made in Berlin upon 2,238 children about to enter school, the girls were inferior to the boys in knowledge of three-fourths of the concepts embodied in the test. They showed greater familiarity with objects within their immediate environment while

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[1] From the Institute of Child Welfare and College of Education, The University of Minnesota.

[2] The writer wishes to acknowledge her indebtedness to Dr. Florence L. Goodenough of the Institute of Child Welfare, University of Minnesota for advice and assistance throughout the progress of this study.

the boys were better able to grasp more specialized concepts, a knowledge of which was likely to be gained through adventuring into more remote surroundings. Numbers were more readily understood by the boys, but the girls excelled in space concepts.

Repeated tests over a five year period were given by Hartmann to 1,312 children ranging in age from five and three-fourth to six and three-fourth years, in the Annaberg schools. The boys were found to excel in certain concepts referring to animals, minerals and social relations. However, the boys on the average were acquainted with only 36 of the objects considered, while the average score for the girls was 56. This finding is in apparent contradiction to results previously quoted, but it is explained by Hartmann's conclusion that while the girls excelled the boys at the beginning of their elementary education, this discrepancy became less and less until the sixth year, after which the boys took the lead. It should also be noted that Hartman's questionnaire included a greater number of items dealing with the immediate environment of the child than did those used by Hall and Lange.

Olson, whose study is reported in another book by G. Stanley Hall, "Aspects of Child Life and Education," worked with 5,000 children, cataloguing their information on 100 subjects. In this study the children were examined singly by different teachers rather than in small groups as were the subjects in the above mentioned studies. While the girls evidenced fewer clear ideas than the boys, they surpassed them in their grasp of religion, funerals, affective ideas in general, and the seasons.

Terman (2) in reporting the total score attained in an information test involving history, geography, the arts and sciences, calls attention to the consistent superiority of boys over girls throughout the entire range of chronological ages, six to fourteen years, included in this study. Considering the scores on the test as a whole, the six year old boys identified ten more items than the girls did. The largest differences in favor of the boys were apparent in history and civics. In art information, language and literature the six year old girls scored practically as high as did the boys; but in geography the boys were slightly superior to the girls.

The possibility that a difference in the nature of the items included may result in quite diverse conclusions makes any generalization regarding the various studies somewhat questionable. However, the weight of evidence appears to indicate that boys have a wider range of information than girls and that idiosyncrasies due to sex interests are present. The girls show themselves superior in comprehending the commoner elements in their environments while the boys have more specialized concepts and fewer that are widely diffused. Moreover in the earlier studies as reported by Hall the conditions and methods employed were not as well controlled nor as uniform as it would have been possible to make them. The children were tested in small groups by teachers untrained in scientific procedure. Hall acknowledges that children were almost twice as likely to profess knowledge of a concept when they were in classes as when they were being tested in groups of eight or ten children.

NATURE OF THE PRESENT STUDY

This is an attempt to evaluate by means of an improved technique the amount and type of general information that young children have at their command upon entering the elementary school. Only children in the second half year of kindergarten were used as subjects in the investigation. The range of chronological ages was from 5 years 4 months to 6 years.

An objective examination was composed and given under uniform conditions. While this test is obviously not sufficiently exhaustive to show the amount of information possessed by any child, it does show with considerable accuracy how he compares with other children of his age in this respect. *The greater number of items included* have to do with objects fairly common in the environment of most urban children, or with those that form common topics of conversation.

DEVELOPMENT OF THE METHOD

After several hundred questions had been formulated, a preliminary test was given to determine those questions best suited to the mental attainments of the children. The items themselves were collected during several weeks of daily observation of kindergarten classes to discover what the children were most likely to be acquainted with and talk about. In addition, a number of questions were suggested by research workers in the field of child development. Questions of phraseology were decided empirically by means of a survey made upon 15 children. A tentative form was tried out individually with 3 children and necessary changes were made on the basis of the combined responses. The revised *form was then tried with three other* children, and the process repeated until a fifth revision which appeared to yield satisfactory results had been worked out.

After deciding upon the questions to be included in the test, these in turn were divided into eleven categories: Local Points of Interest, Time and Number, Current Topics and History, Natural Phenomena, Literature and Music, Animals, Birds and Insects, Plants and Flowers, Occupations and Industries, Household Arts, Simple Mechanics, and Games and Amusements. Two forms of supposedly equal difficulty were devised. Each form included 6 questions under each *of the eleven divisions or categories,* making a total of 132 questions.

As will be seen from the questionnaire which follows, both forms are as nearly equal as to content and difficulty as it was possible to make them. An attempt was made to grade the questions within each category with reference to difficulty as follows:

1. A very easy question (roughly estimated to evoke 90 per cent or better correct answers).
2. An easy question (75 per cent to 90 per cent).

3–4. Two questions of average difficulty (25 per cent to 75 per cent).

5. A difficult question (10 per cent to 25 per cent).
6. A very difficult question (less than 10 per cent).

A group of 100 children, fifty boys and fifty girls, was chosen from seven different kindergartens on the basis of paternal occupation apportioned according to representation in the total population of Minneapolis. Table 1 describes the numerical composition of the group in terms of an occupational classification based upon the Barr Scale for Occupational Intelligence and the Taussig Industrial Classification. A description of this revised classification has been published by Florence L. Goodenough.

TABLE 1

Composition of the experimental group

OCCUPATIONAL GROUP	NUMBER OF BOYS	NUMBER OF GIRLS	TOTAL	TOTAL POPULATION OF MINNEAPOLIS
				per cent
I. Professional	3	3	6	5.4
II. Semi-professional and managerial	3	3	6	6.3
III. Clerical and skilled trades	19	19	38	37.3
IV. Semi-skilled trades and minor clerical	12	12	24	24.3
V. Slightly skilled	7	7	14	14.9
VI. Unskilled labor	6	6	12	11.8
Total boys	50			
Total girls		50		
Total for both sexes			100	

EXPERIMENTAL CONDITIONS

The writer administered both forms of the test always in the A-B order, within a time interval of 7 days. Each child was tested individually during regular school hours in a private classroom, where there was little or no chance for disturbance. The examiner always recorded the verbatim responses; and, although no time limit had been set the time consumed was noted to the nearest whole number of minutes. There was no excessive urging nor additional help beyond the repetition of the question or, in cases of doubtful responses, further questioning, such as, "Tell me what you mean." or "Explain" or "What do you mean by that?" As a rule, the children were very coöperative, regarding the examiner as one of the teachers and looking upon the procedure as a part of their school program. The writer did her best to cultivate a conversational tone of voice and to ask the questions in a casual manner.

When Form A of the test was given, three questions noted on the examination sheet were used as an introductory exercise. These were not scored. If the child failed to respond to these questions the answers were supplied by the examiner.

TYPES OF RESPONSE CREDITED

Such questions as the number of wings a butterfly has, the time it is at midnight, the color of a crow, the number of pennies in a dime, etc., obviously, are easy to score and need no further comment. For the remainder a few general principles will indicate the nature of the credits allowed:

1. In items comparable to "What is Dayton's?" "What is WCCO?" the specific responses of "store" and "radio station" were not required but any reply showing knowledge of Dayton's as a place where you buy things or any connection of WCCO with radio was credited.

2. For items such as "Who is Andy Gump, Lindbergh, Dempsey, Coogan, Hoover, Skeezix, Coolidge, Joesting and Smith," any distinguishing characteristics were credited. For Lindbergh, the association with airplanes or flying constituted an adequate answer.

3. In such questions as "From what does leather come?" "Where does coal come from?" the origin had to be known. For the first of these, "cow" or any other animal from whose skin leather can be made was credited as well as "animals."

4. The items on carpenters and plumbers were credited as answered correctly if any activity that is ordinarily associated with their occupations was given.

5. Whenever the answer was ambiguous, a further question asking for an explanation usually gave sufficient basis for deciding whether credit was to be allowed.

6. The following is a list of items offering more possibilities of variation in response and for which there are necessary restrictions as to credit.

What is the name of a lake in Minneapolis?

Any lake immediately surrounding Minneapolis but not necessarily within the city limits was credited. Minnetonka, perhaps, its best known lake, was always accepted as a legitimate reply, although it is near Minneapolis rather than in it.

What is the Mississippi?

River, only, was credited.

Of what is snow made?

Water, rain or water, rain, ice.

What are the clouds made of?

Rain, snow, smoke, water.

On what part of the violin do you play?

Strings, rubber bands, wires.

How do you play a cornet (or a saxaphone)?

Blowing or playing with your mouth was required.

What does a cat scratch with?

Paws, claws, nails on paws, scratchers on paws, nails on feet.

What color is wheat when it is ripe?

Yellow, golden, tan, golden brown, brown.

What is butter made from?

Milk and cream were both allowed.

How are trees made into boards?

Saw, saw-mill, saw-machine.

Of what is ice made?

Water, frozen water, rain.

Types of incorrect response

The variety and quality of the incorrect responses provide the most interesting and colorful phase of an analysis such as this. One of the outstanding characteristics of the young child is his tendency to absorb the color of his surroundings and to manifest such an inclination by his ingenuous questions or remarks. Jacky Coogan is "the boy on Lawrence's sweater" or "makes shoes downtown;" the nearest city is "Southeast;" Al Smith "made our sidewalk," "He's our preacher," or "he's out at Ham Lake," where the family spent the summer. One boy could not give the name of any newspaper but ended a vivid description of a recent sensational murder case with the convincing statement, "That's the paper we take!"

Euphonic analogy and slang associations account for a number of incorrect responses. A carpenter fixes carpet sweepers or repairs cars; energine is put in the radiators of cars; the Great Northern is the North Star; butter is made from buttermilk or butterflies make it; plants, seeds, and flowers are manufactured in the Ford Plant; baking powder is what ladies use on their faces. A plumber plumbs, pulls out plums or sells plumbers. Other mistakes are the result of mere word associations. Dempsey-Tunney was sometimes given in answer to the question "Who is Dempsey," Butter is made from oleomargerine or Land O'Lakes; beans grow in gardens but bees make them. More or less intimate associations with certain phenomena or common characteristics of color or form produce such misconceptions as snow being made from sand "because sand is grey." Juvenile literature is responsible for replies similar to: "Clouds are made of animals" the result of hearing a verse in which children see animals in the clouds; and "butter is made from tigers," which is true of the tigers in the story of Little Black Sambo.

While such influences are apparent in a variety of incorrect responses, there are others of which the origin is less easily explainable. According to the careful elaboration of one child, coal is made at the North Pole by God. He ships it out to the people on earth who are still in need of such mortal comforts. The heat in the summer time comes from stoves at the South Pole. When the stoves are turned off it's cold. A thermometer tells how to be good or how much you weigh or "no danger—railroad crossing." Butter is made from yellow sunshine or from a windmill. Paper is made from iron, bread, dough or glue. A man who raises corn or wheat is called a bachelor.

RESULTS

Reliability of the total score

Reliability has been computed by correlating the scores made on Form A against those made on Form B. It will be recalled that Form A was always administered first. The form-versus-form method of computing reliability is commonly regarded as a more rigorous test of consistency of measurement than either the test-retest or the split-scale method. The test-retest method is likely to yield results which are spuriously high due to the operation of memory factors; the split scale method is likely to be similarly affected, particularly in the case of young children, by the operation of such factors as shyness, negativism or fatigue which are incident to the immediate situation but not pertinent to the general field of inquiry. Both these sources of error are avoided by the method used in this investigation. The results are shown in table 2.

The total scores on the separate parts of the test for each individual child are very similar. One point was allowed for every response credited, so that a perfect score on either form was 66 and a perfect combined score, 132. The range of scores on the two forms is almost identical; in A from 15 to 55, in B from 14 to 52 points. The mean on Form B is 1.6 points higher than that on Form A. Whether this is the result of practice or of a slight difference in the difficulty of the two forms cannot be determined from our data. The standard deviations of the two forms are also very similar. According to the combined scores the average child possessed a knowledge of 71.6 of the concepts enumerated in the test. Among the 13 highest scores, 11 were earned by boys and only 2 by girls.

Reliability of the separate categories

Table 3 gives the reliability of the individual categories, their means and standard deviations, and the ratio of the actual difference between means to the standard error of the difference for the sexes and for the upper and lower halves of the occupational groups.

As was to be expected, these reliability coefficients are much lower than that of the total scale. For our group of subjects, Category VI, (animals,

TABLE 2

Reliability of the information test

	PEARSONIAN r	P.E.	MEAN	S.D.
Form A vs. Form B	.94	.008	(A) 36.2	9.8
Combined scores (Spearman Brown Formula)	.97	.003	(B) 37.8	9.5

TABLE 3

Reliability of the separate categories

Differences between occupational classes and between boys and girls

CATEGORY	RELIABILITY				MEAN					
	Uncorrected	Spearman Brown	Mean total	S.D. total	Upper half	Lower half	$D/\sigma D$	Girls	Boys	$D/\sigma D$
VIII. Local	.55	.71	5.8	2.5	7.5	5.0	5.3	5.2	6.5	2.8
II. Time and number	.69	.83	6.6	2.0	7.0	6.3	1.9	6.7	6.7	.1
III. Current topics and history	.65	.78	5.4	2.1	6.3	4.6	4.7	5.0	5.9	2.3
IV. Natural phenomena	.29	.45	6.7	1.7	7.6	5.8	6.2	6.7	6.6	.3
V. Literature and music	.52	.68	6.3	2.1	7.1	5.5	3.6	6.1	6.8	1.4
VI. Animals, birds and insects	.80	.80	6.7	1.7	7.4	6.0	4.7	6.4	7.0	1.7
VII. Plants and flowers	.37	.54	6.5	2.6	7.6	5.0	4.2	6.4	6.6	.4
VIII. Occupations and industries	.62	.77	7.3	2.4	8.6	6.1	4.7	6.0	7.7	1.8
IX. Household arts	.33	.50	7.1	2.2	8.1	6.9	3.5	7.1	7.0	.2
X. Mechanical	.65	.79	6.7	2.5	8.2	5.5	6.8	5.9	7.5	3.5
XI. Games and amusements	.61	.76	4.4	2.1	5.0	3.7	3.3	3.7	5.2	3.8
Composite A and B	.94	.97	71.6	19.1	80.0	63.0	4.9	67	78	2.9

birds and insects) was most reliable, while Categories VII (plants and flowers) and IV (natural phenomena) showed least agreement between the two forms.

Correlation with the Detroit kindergarten test

The Pearson product moment correlation between the combined scores or the two forms of the information test and the Detroit intelligence test for kindergarten children was +.64 ±.04. A number of factors which tended to lower this correlation should be noted. The Detroit test is supposed to be given to all pupils during the first and second months of school, but in some cases it was postponed for as much as four or five months. Since age-norms for this test had not been published at the time of this study, it was not possible to correct for discrepancies in age resulting from irregularities in the time of administration. Each of the cases was examined by his respective teacher. The tests were given by the kindergarten teachers, and it is doubtful whether the standardized procedure was strictly followed in all cases. In one instance, a teacher is known to have changed a certain part of the test which she thought unfair to the child. The mean Detroit score for the group was 18.9 which corresponds closely to the mean scores for other kindergartens in the city. It is of interest to note that the scores made by a pair of identical twins differed by two points on the Detroit test and three points in combined score on the information test. Since the range of scores is much greater in the information test than on the Detroit test the resemblance in information is closer than that indicated by the Detroit test.

Average time for administration

The average time for giving Form A was 19 minutes, for giving Form B, 17 minutes, making the total time consumption for both forms, 36 minutes. A correlation of +.51 between time on the first and time on the second occasion shows that there is some consistency in the speed in which the child reacts to the questions from occasion to occasion.

TABLE 4

Percentile distributions for the composite scores according to occupational groups and sex

PERCENTILE	OCCUPATIONAL GROUP		SEX	
	Upper half	Lower half	Girls	Boys
10	52.8	36.5	39.5	51.2
20	65.9	45.9	48.5	61.2
30	72.5	54.5	57.0	69.5
40	77.5	59.8	62.3	73.1
50	81.2	63.8	67.0	76.6
60	83.9	69.5	75.7	80.2
70	90.3	75.3	80.9	83.8
80	94.5	79.5	84.5	92.8
90	102.–	84.5	90.8	101.2
95	106.4	88.7	93.9	105.3
100	107	102	107	107

Occupational group and sex differences

A comparison of total composite scores on the first three with the last three occupational groups gives evidence of the general superiority of the former, the mean of the two differing by 17 points and the ratio between the actual difference and the standard error of the difference being 4.9. There is very little difference in the standard deviations for the upper and

TABLE 5

Percentage of successes on individual items by occupational group and sex

	OCCUPATIONAL GROUPS		SEXES		
	I, II, III	IV, V, VI	Girls	Boys	Total
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Preliminary Exercise (not scored):					
1. Tell me the name of a street. (If no response, On what street do you live?)					
2. *What is a robin?*					
3. Of what flowers can you tell me the name?					
Category I. Local Points of Interest:					
1. Tell me the name of a Minneapolis newspaper	90	80	80	90	85
2. What is the name of a lake in Minneapolis.	40	14	24	30	27
3. *What is the Mississippi*	78	78	76	80	78
4. What is Hennepin Avenue	54	50	54	50	52
5. What is the Great Northern	46	32	30	48	39
6. What is W. C. C. O	68	44	50	62	56
1. What is Dayton's	92	92	96	88	92
2. What large city is closest to Minneapolis.	42	16	18	40	29
3. *What do they make in the Ford plant*	54	48	42	60	51
4. *What do people go to look at in the Art Gallery*	8	2	4	6	5
5. In what city is Minnehaha Falls	52	36	32	56	44
6. Tell me the name of a hotel in Minneapolis	26	6	10	22	16
Total per cent on all 12 items	54.2	41.5	43	52.7	47.8
Category II. Time and Number:					
1. How many pennies in a dime	24	20	18	26	22
2. *What time of year do flowers grow outdoors*	100	98	100	98	99
3. What time of year is the weather cold	96	88	92	92	92
4. How many eggs in half a dozen	10	14	12	12	12
5. What day comes after Sunday	84	66	76	74	75
6. What time or what o'clock is it at noon	28	32	22	38	30
1. *How many pennies in a nickel*	40	34	40	34	37
2. How many hands has a clock	96	92	94	94	94
3. What time of the year is the weather hot.	98	80	90	88	89
4. *How many eggs in a dozen*	18	6	8	16	12
5. What day comes after Saturday	88	84	90	82	86
6. What time or what o'clock is it at midnight	24	20	24	20	22
Total per cent on all 12 items	58.8	52.8	55.4	56.2	55.8

TABLE 5—*Continued*

	OCCUPATIONAL GROUPS		SEXES		
	I, II, III	IV, V, VI	Girls	Boys	Total
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Category III. Current Topics and History:					
1. Who is Andy Gump	90	58	80	68	74
2. What did Lindbergh do	90	84	80	94	87
3. Who was the first president	68	42	54	56	55
4. Who is Dempsey	62	64	46	80	63
5. Who is Jacky Coogan	24	20	16	28	22
6. Who is Herbert Hoover	0	0	0	0	0
1. Who is Skeezix	90	72	80	82	81
2. What are the colors in the flag	100	90	94	96	95
3. What people lived in America before the white men did	36	8	14	30	22
4. Who is Joesting	14	2	4	12	8
5. Who is Coolidge	56	20	34	42	38
6. Who is Al Smith	2	0	0	2	1
Total per cent on all 12 items	52.7	38.3	41.7	49.4	45.5
Category IV. Natural Phenomena:					
1. What shape is the sun	96	74	84	86	85
2. Of what is snow made	80	70	72	78	75
3. Where do you sometimes see a rainbow	80	62	68	74	71
4. What makes it warm in the summer time	98	84	94	88	91
5. Where does the sun set in the evening	16	8	10	14	12
6. What are clouds made of	34	34	34	34	34
1. Where are the clouds	100	98	98	100	99
2. Of what is ice made	96	82	90	88	89
3. What makes it light in the daytime	92	72	86	78	82
4. What shape are snowflakes	14	2	8	8	8
5. Where does the sun rise in the morning	40	26	38	28	33
6. What is lightning made of	10	0	4	6	5
Total per cent on all 12 items	63	51	57.2	56.8	57
Category V. Literature and Music:					
1. What colors are the keys on a piano	92	76	82	86	84
2. Whom was Red Riding Hood going to see	68	48	54	62	58
3. What did Cinderella lose at the ball	50	26	36	40	38
4. On what part of the violin do you play	52	40	38	54	46
5. Who was Hiawatha	12	2	6	8	7
6. How do you play a cornet	28	20	18	30	24
1. What did Jack and Jill do	96	92	96	92	94
2. With what do you play a drum	96	92	92	96	94
3. When the three bears came home, whom did they find in bed	92	78	84	86	85

TABLE 5—*Continued*

	OCCUPATIONAL GROUPS		SEXES		
	I, II, III	IV, V, VI	Girls	Boys	Total
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
4. What was the name of the boy who climbed the Beanstalk	58	30	36	52	44
5. What was Cinderella's coach or carriage made of	16	6	10	12	11
6. How do you play a saxaphone	54	44	34	65	49
Total per cent on all 12 items	50.5	46.2	48.8	56.8	52.8
Category VI. Animals, Birds, Insects:					
1. How many legs has a horse	100	100	100	100	100
2. What does a cat scratch with	98	96	98	96	97
3. From what are little chickens hatched	74	52	60	66	63
4. What do bees make that we eat	74	44	52	66	59
5. A baby dog is called a puppy; what is a baby cow called	32	20	20	32	26
6. What do we call a butterfly before it becomes a butterfly	30	8	10	28	19
1. What do we drink that we get from a cow	100	98	98	100	99
2. What color is a crow	40	26	30	36	33
3. A bird flies in the air; what does a fish do in the water	94	80	84	90	87
4. How many horns has a cow	84	90	88	86	87
5. A baby cow is called a calf; what is a baby horse called	12	12	10	14	12
6. How many wings has a butterfly	4	14	8	10	9
Total per cent on all 12 items	61.8	53.3	54.8	60.3	57.5
Category VII. Plants and Flowers:					
1. What do apples grow on	100	94	94	100	97
2. What color are buttercups	38	22	32	28	30
3. What color is wheat when it is ripe	40	30	38	32	35
4. How many stones in a peach	80	64	78	66	72
5. What do we call the part of the plant underground	42	22	22	42	32
6. What do we eat that grows on vines	36	22	30	28	29
1. What must we plant to have flowers	98	92	92	98	95
2. What color are dandelions	80	60	74	66	70
3. What do we call a flower before it opens	50	22	34	38	36
4. What color is an apple before it is ripe	74	58	68	64	66
5. What is the outside of a tree called	42	10	18	34	26
6. What do we eat that grows under the ground	76	42	56	62	59
Total per cent on all 12 items	63	44.5	53	54.5	53.7

TABLE 6—*Continued*

	OCCUPATIONAL GROUPS		SEXES		
	I, II, III	IV, V, VI	Girls	Boys	Total
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Category VIII. Occupations and Industries:					
1. Who makes money by cutting hair	96	96	98	94	96
2. To whose office do we go to get a tooth pulled	100	90	96	94	95
3. What does a plumber do	74	46	52	68	60
4. What is butter made from	52	28	36	44	40
5. What is a shoe made of	90	68	76	82	79
6. Where does coal come from	36	28	30	34	32
1. Who brings letters to the house	100	96	100	96	98
2. Who takes people's tonsils out	98	84	88	94	91
3. What do we call a man who raises corn and wheat	64	50	50	64	57
4. What does a carpenter do	62	58	42	78	60
5. Where does wood come from	80	58	54	84	69
6. What is paper made from	32	18	22	28	25
Total per cent on all 12 items	73.7	60	62	71.7	66.8
Category IX. Household Arts:					
1. What do we use to cut cloth	100	100	100	100	100
2. From what animal do we get bacon	28	22	24	26	25
3. What is the outside of an egg called	80	60	78	62	70
4. What is a vacuum cleaner used for	98	90	92	96	94
5. From what does leather come	24	10	16	18	17
6. From what do we get wool	46	42	42	46	44
1. What do you use to cut meat	100	100	100	100	100
2. What do you put with the lemon juice to make lemonade	86	78	82	82	82
3. How do we get water out of clothes before hanging them up to dry	96	84	86	94	90
4. For what is baking powder used	92	76	82	86	84
5. What is the yellow part of an egg called	40	20	34	26	30
6. From what do we get cotton	16	6	4	18	11
Total per cent on all 12 items	67.2	57.3	61.6	62.9	62.2
Category X. Simple Mechanics:					
1. What do you use to put a screw into wood	78	72	62	88	75
2. What do you see on the ground that trains run on	100	96	96	100	98
3. What is the brake on an automobile for	62	48	38	72	55
4. How are trees made into boards	30	8	10	28	19
5. What is a thermometer for	74	26	42	58	50
6. Gas or gasoline makes an automobile go; what makes a streetcar go	20	4	6	18	12

TABLE 5—*Concluded*

	OCCUPATIONAL GROUPS		SEXES		
	I, II, III	IV, V, VI	Girls	Boys	Total
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
1. What do you use to put a nail into wood.	98	98	96	100	98
2. What do you use a saw for.............	100	100	100	100	100
3. What is sandpaper for..................	58	32	44	46	45
4. How can you get to the top floor of a building without walking.............	66	42	54	54	54
5. What makes a sail-boat go.............	60	30	32	58	45
6. What do we put in the radiators of automobiles............................	56	50	50	56	53
Total percentage on all 12 items.........	66.8	59.7	52.6	64.8	58.7
Category XI. Games and Amusements:					
1. How do you play leapfrog...............	32	10	18	24	21
2. What do people fish with................	98	94	92	100	96
3. What must you not do in tin-tin........	0	2	2	0	1
4. On what do people play hockey in the wintertime..........................	64	56	40	74	60
5. In what game do you have a king-row...	10	10	2	18	10
6. In what game do you have a touchdown.	40	16	14	42	28
1. What do we use to play croquet.........	42	24	22	44	33
2. What are skiis made of..................	94	90	94	90	92
3. What must you have to play anty-over..	4	10	6	8	7
4. What do people play bridge with........	48	30	42	36	39
5. In what game do you use a racket.......	34	18	18	34	26
6. In what game do you have a home run..	26	26	8	44	26
Total per cent on all 12 items...........	41	32.2	30.3	42.8	36.5

lower halves of the occupational groups; for the former it is 17.8 and for the latter, 16.5. As a whole, the boys exceed the girls in number of successes, the average boy having a knowledge of 10 more items than the average girl. In this instance, the ratio between the standard error of the difference and the actual difference between means is 2.85. Whatever superiority on entire categories exists is always in favor of the boys and invariably in favor of the upper half of the industrial classification. Individual items occasionally show a larger percentage of passes for the girls; this is also true of the lower occupational groups. In these cases, however, the superiority is so slight as to be practically negligible.

Table 4 presents comparisons between the two divisions of the occupational groups and between the sexes in the form of percentile scores. As is evident from table 3, the discrepancies between the means for the sexes on the separate categories are in some instances very small; those between the upper and lower halves of the occupational levels, although not always significant, appear more consistently and are more marked.

Percentages of success on individual items

Table 5 shows, for the upper and lower halves of the occupational distribution and for the sexes separately, the percentage of cases succeeding with each individual item in the two forms. Each of these sub-groups includes exactly 50 cases.

Analysis of successes on individual items

A small number of items show about an equal number of successes for both divisions of the occupational groups; others show little or no sex difference, while a majority of them gave evidence of considerable difference between socio-economic groups and a somewhat smaller proportion indicate a dissimilarity in the type of information likely to be possessed by the two sexes.

The time of year that flowers grow outdoors, the number of eggs in a dozen, the day of the week after Saturday, the time it is at midnight, and most of the other questions in the Time and Number subdivision evoke about the same number of correct answers from both sexes. Boys excel the girls by 16 per cent in naming the time at noon. Jacky Coogan, Dempsey, Lindbergh, and Coolidge are better known by the boys. The most pronounced sex difference in favor of the boys is on Dempsey. He and Lindbergh, however, are equally popular with both the upper and lower social classes. The political situation in regard to Hoover and Al Smith apparently had no significance for five year olds. This study was made during the heat of the political campaign in the fall of 1928. Most of them are completely mystified by the question, or associate the family name of Smith with that of a next-door neighbor.

In phenomena of nature, both sexes alike have approximately the same range of information, which does not coincide with the supposition that girls surpass boys in objects relatively common in their surroundings. However, in this category the upper strata of socio-economic groups exhibit quite an advantage over the lower, the ratio of the actual difference between means to the standard error of the difference being 6.16. Contrary to what has been found in previous studies, the boys do not excel the girls in all "animal" concepts, although they do so on "what bees make" the caterpillar preceding the butterfly and a "baby" cow being called a calf. Category VIII on Occupations and Industries as a whole does not display a significant advantage for either sex, but on such items as wood coming from trees, the work of a carpenter, and the nature of a plumber's occupation boys show superiority. The dentist and the doctor are equally well known in all levels of social life. It is an interesting observation that, at the age of five, boys know quite as much about the particular concepts included in the sub-group on Household Arts as do the girls.

The most distinct gap between the scores of occupational groups on any one category occurs in Mechanics and Transportation where the ratio of the actual difference in the means to the standard error of the difference is 6.78.

As is to be expected the sex distinctions in this sub-group are also quite marked. There is close agreement between the sexes in knowledge as to what can appropriately be put in the radiator of an automobile, while the result of the operation of the brake is almost twice as often understood by boys as by girls.

Category XI on Games and Amusements is unique in that the ratio of the standard error of the difference to the actual difference for the upper and lower occupational groups exceeds the corresponding difference between the sexes by only .5. This is the only instance in which such an approximation has been reached; in all the others the social group distinctions outweigh the sex differences by a much greater margin. Boys excel in naming the correct game in which touchdowns and home runs play a part and in recognizing hockey and tennis terms.

SUMMARY OF RESULTS

1. Two forms of a general information test were administered to 100 children, selected to represent approximately the various socio-economic groups within the population of Minneapolis and divided equally as to sex.

2. The test was formulated after observing kindergarten children to ascertain what topics were actually discussed by them, and by using suggestions made by trained and experienced workers in the field of preschool research.

3. The reliability of a single form of the range of information test, calculated by the Pearson product moment method, is +.94. According to the Spearman-Brown formula the reliability of the combined scores on the two forms is +.97.

4. When correlated with the Detroit Kindergarten test, there is a relationship of +.64 between intelligence and range of information, which is probably too low, due to defects in the administration of the Detroit test.

5. The total time required for giving both forms of the test is thirty-six minutes. There is a correlation of +.51 between time on Form A and time on Form B.

6. There are marked differences in range of information between upper and lower halves of the socio-economic groups, the ratio of the actual difference between means to the standard error of the difference being 4.9.

7. Sex differences in favor of the boys, while less marked than those between social classes are great enough to be reliable. The difference between the mean scores earned by the two sexes is 2.85 times the standard error of the difference. It is apparent in each of the eleven categories but is greatest in regard to mechanical information and games and amusements.

REFERENCES

(1) HALL, G. STANLEY: The contents of children's minds on entering school. Pedagogical Seminary, 1891, 1, 139–173.

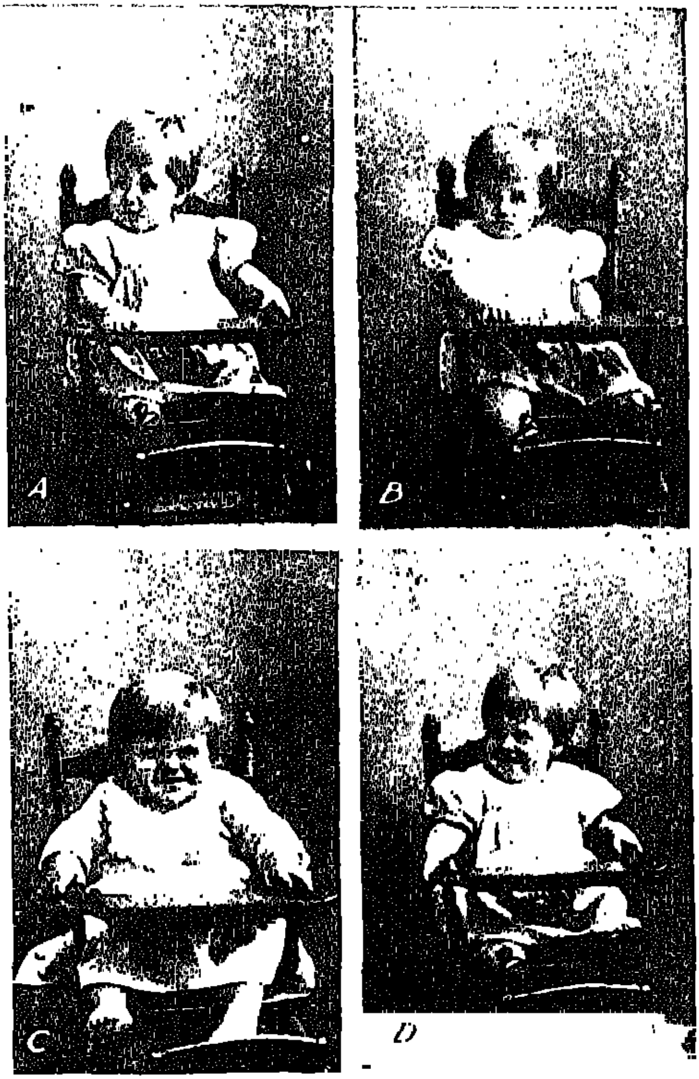
(2) TERMAN, L. M.: Genetic studies of genius. Vol. 1, Stanford University Press, 1925, pp. 206, 298, 582–584.

The Expression of the Emotions in Infancy

FLORENCE L. GOODENOUGH

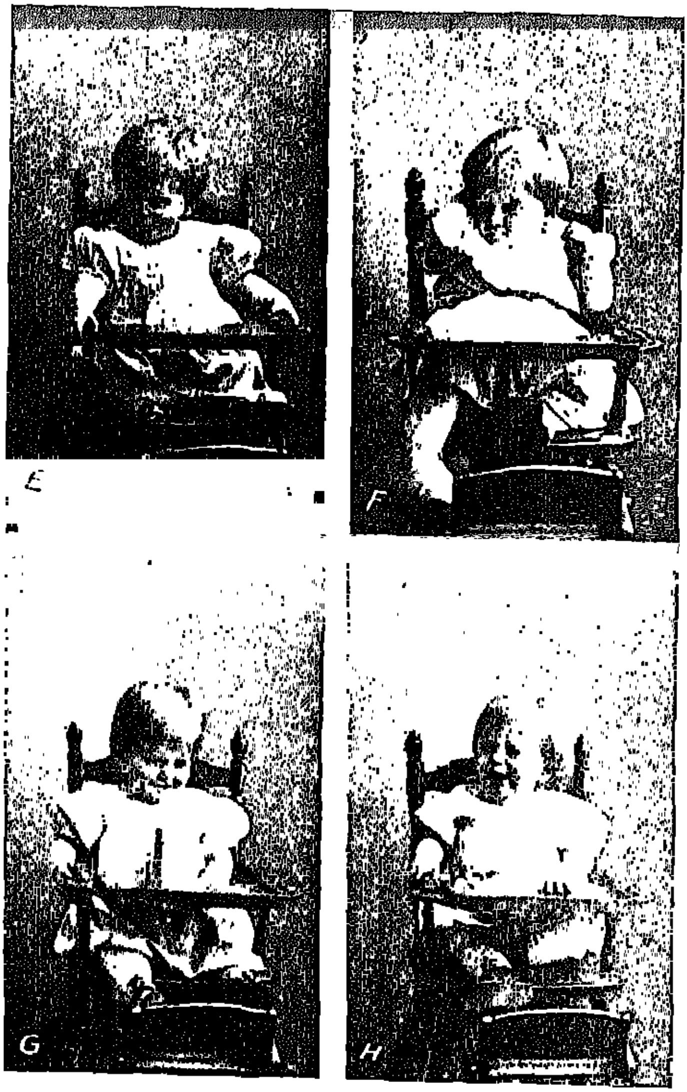
THE question of the relative influence of "native" vs. "learned" elements in the overt expression of the emotions has been a point of controversy for several years. For a critical review and bibliography of the literature on this topic the reader is referred to Landis (2). Repeated experiments have shown that facial expression alone as shown in the ordinary still photographs of adults posed to simulate various types of emotional expression is an inadequate basis for identifying emotion, since there will usually be much disagreement among judges as to the specific emotions which the different photographs were designed to portray. Even less agreement has been found when the material consists of photographs taken in the laboratory under conditions of genuine emotional excitement or strain. These results have led some persons to the conclusion that the facial expression of emotion is in the main a learned reaction, functioning primarily as a form of language. Like other languages it may be expected to differ somewhat from one social group to another, and to become modified in various ways with the passage of time.

That the overt expression of emotion among adults may be inhibited or simulated in order to conform to social standards can hardly be doubted. It seems improbable, however, that such modification of expression either for the purpose of concealment of emotion or of conveying the idea of an emotion not actually felt will occur during the first year of life; while anyone who has ever attempted to induce a young infant to imitate an action performed in his presence may well doubt whether any large proportion of the changes in facial expression shown at those early ages have been brought about through either conscious or unconscious imitation. It seems worth while, therefore, to ascertain the extent to which adults who have had some experience with young children are able to interpret the expressive behavior of infants with sufficient accuracy to enable them to match photographs taken under conditions assumed to be provocative of some degree of emotional response with the written descriptions of the situations under which each was taken. A very careful investigation of this nature is reported by Mandel Sherman (3). Sherman's subjects, however, were new-born infants whose movements are but slightly coordinated and who, presumably, had not yet fully recovered from the shock of birth. He found that without a knowledge of the stimulus, agreement between observers as to the character of the emotion which the infant was presumably experiencing was no greater than would be expected by chance. We are not warranted in assuming that similar results would be obtained for older infants.



As material for this study, a series of eight pictures selected from "Die Entwicklung der Gemütsbewegungen im ersten Lebensjahre" by Martin Buchner (1) was used. These photographs, which are reproduced by permission of the publishers, are shown.

They were taken under conditions thought favorable for the eliciting of mild emotional states at an instant when the behavior of the infant suggested to the observer that the anticipated emotion had been aroused. The youth of the subject (ten months) renders it highly improbable that the character of the expression had been affected to any marked degree by social *tradition*. For the same reason, "camera consciousness" may safely be ruled out.



Descriptions of the situations under which the photographs were taken are given by Buchner in the monograph cited, together with a brief characterization of the emotion which the child was believed to be experiencing. These descriptions were translated literally except for the omission of certain specific references which might serve as a guide to the matching. Descriptions of four other photographs not used in the experiment were added to the list in order that the matching of the last picture would not be determined automatically by a process of elimination. A group of 68 university students enrolled in a course in child training served as judges. Each student was given a set of photographs and a mimeographed sheet of instructions as follows:

JUDGING EMOTIONS FROM PHOTOGRAPHS

Instructions: You will be given a series of photographs, labelled on the back A, B, C, D, E, F, G, H, respectively. Below is a series of paragraphs describing the situations under which the photographs were taken. In some instances the emotion which the child was believed to be experiencing is also indicated. Descriptions of four additional situations have been added, in order that the matching of the last picture will not be determined automatically by a process of elimination.

Look at the first picture (labelled A). Note the child's facial expression and bodily posture carefully. Then read through the descriptions of all situations in which the child was photographed. One of these corresponds to Picture A. When you have decided which one of the situations described would be most likely to elicit the expression shown in the picture, write the letter A in the parentheses preceding this description on the mimeographed sheet. Do the same for Picture B, then for Picture C, and so on until all the pictures have been matched. Four unmatched situations will of course be left over.

Do not omit any of the pictures. Make a judgment each time, even if you feel very uncertain as to the correct choice. State only one judgment for each picture.

Situation

Picture

( ) 1. Satisfied smiling (with affection). He was looking at his mother who talked to him in a friendly manner.

( ) 2. Astonishment (with slight displeasure). I counted loudly and emphatically as I walked toward him—'twenty, twenty-one, twenty-two, etc.' He looked me uncomprehendingly in the face.

( ) 3. Fear (perhaps with dislike). A strange woman struck two blocks together, growled, and rushed suddenly up to him, frowning darkly.

( ) 4. Dissatisfaction (with slight obstinacy). I had taken him up in my arms and then put him back in the chair. He wanted to come to my arms again.

( ) 5. Astonishment (with auditory attention). He is listening to the ticking of a watch.

( ) 6. Slight obstinacy. His mother wanted him to give her his hands, but he would not because she had just taken a toy away from him.

( ) 7. Crying. He was tired of sitting and wanted to come out of his high chair into my arms.

( ) 8. Astonishment (with ocular attention). A bright colored new toy clown was shown to him.

( ) 9. Grimacing. The rogue is trying to wink.

( ) 10. Pleasure. I rolled a shining tin can on the tray. He said softly "dai."

( ) 11. Roguish smiling (with affection and tense expectation). His mother was teasing him. "Only wait, now, I'm going to catch you!"

( ) 12. Anger (and displeasure). A toy has been taken away from him.

Table 1 shows the distribution of judgments for each of the eight pictures. Correct judgments are shown in the diagonal line of boxes. Of the 544 judgments 258 or 47.4 per cent are correct. The chance expectancy is 8.3 per cent correct judgments The percentages for the different pictures vary from 14.7 for Picture A to 77.9 per cent for Picture C. Inspection of the incorrect judgments will shows that they are far from being distributed at random. In each case they tend to be concentrated within one or more situations which are as a rule closely similar to the correct one. For example, with four exceptions the errors in interpreting Picture A consist in choosing either Situation 2 or Situation 5. In both of these situations as well as in the true one *astonishment* was thought to be the predominant emotion. Likewise in the interpretation of Picture B the majority of the errors consist in selecting Situation 6 rather than 4. Again the resemblance of the two situations is striking. The only important exception to the general rule that confusions are for the most part confined to the situations in which the emotions imputed to the infant are the same or closely similar is to be found in the case of Picture F, which is most frequently attributed to Situation 6. Here the source of the confusion is probably to be found in the child's attitude of active withdrawal. Had the judgments been based upon actual observation of the child's behavior or upon moving pictures it is probable that the comparative speed of reaction (startle reflex) would have served to differentiate the two.

TABLE 1

Distribution of judgments in matching photographs and situations

PICTURE	SITUATION											
	8	4	9	1	11	3	10	7	2	5	6	12
A	10				1	1			33	21	2	
B		14				11			9	1	24	9
C	1	2	53	1	8	1		1		1		
D	1			43	16		6			2		
E	9		3	7	26		7		1	6		
F		11	1			14		1	1	5	30	5
G	12			3	1		50			1	1	
H	1	5			2		3	48				9

SUMMARY AND DISCUSSION

1. An experiment was designed to ascertain the degree of accuracy with which the expressive behavior of an infant as shown in ordinary still photographs can be identified with the descriptions of the circumstances which called it forth. A group of 68 university students enrolled in a course in child training acted as judges.

2. It was found that on the average photographs and situations were matched correctly in 47.4 per cent of the judgments, which is 5.7 times the percentage of successes to be expected by chance. Errors in matching were in the main confined to confusions between situations in which the emotions imputed to the child by the

original investigator were the same or closely similar.

3. Since the subject of the photographs was an infant of ten months, it seems improbable that the form of behavior displayed by him had been appreciably modified by social tradition or by "camera consciousness." Moreover, since the still photographs show only a single brief phase of the total pattern of expressive behavior and afford no evidence as to the speed of reaction or of its vocal accompaniments, and since the stimuli used were for the most part of a comparatively mild nature not calculated to call forth pronounced reactions, the degree of success attained by the judges takes on added significance. The findings suggest that however greatly the overt expression of emotional states may be inhibited, modified, or intentionally assumed in the social relationships of adult life, the language of expression is nevertheless built upon a core of native reaction-patterns which appear at so early an age that they can hardly be ascribed to training. It seems probable that the rôle of training and experience in the expression of the emotions consists chiefly in a process of inhibition and substitution whereby the innate reaction-patterns take on a more or less distorted form. If this hypothesis be correct, the optimum period for the study of emotional expression is to be found in early childhood, before the original patterns of response have become too extensively overlaid by the habits resulting from social experience.

REFERENCES

(1) BUCHNER, MARTIN: Beiträge zur Kinderforschung und Heilerziehung. 1909, 60, pp. 19.

(2) LANDIS, CARNEY: The expressions of emotion. Foundations of Experimental Psychology, Worcester: Clark University Press, 1929.

(3) SHERMAN, MANDEL: The differentiation of emotional responses in infants. J. Comp. Psychol., 1927, 7, 265-283.

A Revised Scale for Measuring Developmental Age in Boys*

PAUL HANLY FURFEY

THE CONCEPT OF DEVELOPMENTAL AGE

IT IS a familiar and obvious fact that the behavior of the growing child changes with age. The irresponsibility of early childhood gives place to the seriousness of adult life. Play shows a wide range of development from the motor play of the infant and the dramatic play of the preschool child to the complex social recreation of the adolescent and the adult. Autistic thinking alters in character. The attitude of the growing child towards other children of the same and the opposite sex undergoes a complex sequence of changes. In fact, the whole psychology of the individual alters as he gradually grows from childhood into adulthood.

These changes may reasonably be ascribed to a volitional and an intellectual element. That is to say, the drives, or the objectives, or the plan of life, of the growing child gradually develop and are slowly transformed from year to year, while his increasing intelligence and his accumulating experience make him able to put into effect more efficiently the said drives or objectives.

The intelligence test movement has made possible the quantitative study of the intellectual element in conduct. We know now, at least in a general way, the effect on behavior of different degrees of mental ability. Little or no effort has been made, however, to study the changing volitional life of the growing child. The term "developmental age" has been introduced by the present writer to cover this element in conduct. It may de defined as "the progressively increasing and non-intellectual maturity of general behavior which shows itself in the growing child's play preferences, in his fantasy life, in his choice of books and movies, in his ambitions, and, in general, in his whole behavior type." In this definition no presuppositions are made as to the ultimate causes of this species of maturity. It may conceivably be due to social custom or to some factor intrinsic to the child himself, or to some combination of extrinsic and intrinsic causes. We do presuppose, however, that developmental age is not the same thing as mental age; for the term has been chosen to denote a type of maturity which is other than intellectual. As will be seen later in the present paper, the existing evidence tends to show that there is little or

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* I desire to thank the many people who have aided in the preparation of this study, particularly my colleague, Dr. Thomas G. Foran.

no correlation between mental age and developmental age, if the effect of chronological age is eliminated.

THE PRELIMINARY SCALE

The present writer has already published a scale for measuring developmental age (1, 2, 4, 6) but it was quite frankly an experimental one. It consisted of 4 tests, two of which dealt with play preferences, one with reading preferences, and one with attitudes. As developmental age is presumably characterized by different qualities in the two sexes this scale was made applicable to boys only. The same is true of the present revised scale. The preliminary scale was given to 450 boys in the city of Washington in May, 1925.

The reliability of this preliminary scale was calculated not on the basis of the entire group but on a special group of 60 boys having a mean chronological age of 161.77 months, with a sigma of 17.29 months. By the method of split halves and the Spearman-Brown formula the reliability of the scale for this group was found to be .76. Of course, a reliability as small as this makes the scale useless except for group comparisons. It did, however, serve to show the possibilities as well as the limitations of the method.

A second defect of the preliminary scale was its extremely cumbersome scoring system. This defect may be illustrated by the scoring of test two which proved to be the most promising of the 4 tests of the scale. This test consisted of a list of activities. The child was instructed to read it through and to mark with one or two crosses respectively the activities which he liked and those which he liked very much. Each item has been assigned a weight in accordance with its value as an index of developmental age. The score for this test was fixed as 100 times the average weight of all items marked by the child. The items which he marked as liked "very much" were counted twice. Practice proved that this method of scoring was very tedious.

THE CONSTRUCTION OF THE REVISED SCALE

In constructing the new test the two defects just mentioned were kept in mind. To be satisfactory, the new test would have to have a reliability at least as high as the standard intelligence and educational tests in use in our school systems and clinics; and the scoring system should not be more difficult than those of the average group test.

In order to obtain a more satisfactory reliability the scale was considerably lengthened and more care was exercised in the selection of items. The final scale consisted of 6 tests dealing respectively with play preferences, vocational ambitions, reading preferences, and things the child would like to have, to see, and to think about.

Various improvements in the scoring system were considered. Finally a method was devised which became known as "the method of paired comparisons." As the name implies, this method consisted in presenting to the child a number of paired alternatives and he was instructed to choose one alternative in each pair. The method is illustrated in the test forms. If the child preferred the first item in

TEST 1*

"THINGS TO DO"

In each pair choose which thing you would like better to do

Would you rather:
1. Dance, or, 2. Play "Puss in the corner" ( )
1. Play with bow and arrow, or, 2. Shoot baskets ( )
1. Go on Scout hikes, or, 2. Knock flies ( )
1. Play golf, or, 2. Play soldier ( )
1. Fly kites, or, 2. Bowl ( )

1. Play with electric trains, or, 2. Read magazines ( )
1. Go to a club meeting, or, 2. Play soldier ( )
1. Read novels, or, 2. Play "Follow the Leader" ( )
1. Listen to a band playing, or, 2. Make candy ( )
1. Work with tools, or, 2. Play tennis ( )

1. Visit museums, or, 2. Play with wagons ( )
1. Play "Drop the handkerchief, or, 2. Dance ( )
1. Collect stamps, or, 2. Play "Cowboys and Indians" ( )
1. Play with bow and arrow, or, 2. Listen on radio ( )
1. Spin tops, or, 2. Take pictures ( )

1. Play "Cops and thieves," or, 2. Go to parties ( )
1. Play the saxophone, or, 2. Play tag ( )
1. Play "I spy," or, 2. Play "Parchesi" ( )
1. Go out with a girl, or, 2. Play with Meccano ( )
1. Make model airplanes, or, 2. Read adventure stories ( )

1. Read sport news, or, 2. Play checkers ( )
1. Play cards, or, 2. Play "Run, sheep, run" ( )
1. Look at toys in stores, or, 2. Go to the movies with a girl ( )
1. Just sit around, or, 2. Play in the sand ( )
1. Play musical instruments, or, 2. Walk on stilts ( )

1. Play indian, or, 2. Have "dates" ( )
1. Dance, or, 2. Play "In and out the window" ( )
1. Play soccer, or, 2. Play with electric trains ( )
1. Walk on stilts, or, 2. Go to card parties ( )

1. Play basketball, or, 2. Read the funny papers ( )
1. Make candy, or, 2. Look at pictures ( )
1. Belong to the Boy Scouts, or, 2. Ride in an auto ( )
1. Repair an auto, or, 2. Read animal stories ( )
1. Erase blackboards, or, 2. Take a walk with a girl ( )

1. Play "I spy," or, 2. Read magazines ( )
1. Write letters, or, 2. Play with toys ( )
1. Drive an auto, or, 2. Go to Scout meetings ( )
1. Do puzzles, or, 2, Play cowboys ( )
1. Play with bow and arrow, or, 2. Play catch ( )

* This scale is published by the C. H. Stoelting Co.

1. Repair an auto,	or, 2. Play circus	( )
1. Chew gum,	or, 2. Go out with a girl	( )
1. Pitch horseshoes,	or, 2. Play soldier	( )
1. Fly model airplanes,	or, 2. Get a letter from a girl	( )
1. Play "Cops and thieves,"	or, 2. Wrestle	( )

1. Play with a pet dog,	or, 2. Play golf	( )
1. Get a letter,	or, 2. Play with electric trains	( )
1. Go to a Wild West show,	or, 2. Go to a musical comedy	( )
1. Go visit a girl,	or, 2. Wade in the water	( )
1. Play croquet,	or, 2. Go to a dance	( )

1. Read the newspapers,	or, 2. Play circus	( )
1. Have tea with a girl,	or, 2. Play with marbles	( )
1. Play with wagons,	or, 2. Go to call on friends	( )

TEST 2

"THINGS TO BE WHEN YOU GROW UP"

In each pair choose the thing you would like better to be when you grow up

Would you rather be:

1. A stock broker,	or, 2. A blacksmith	( )
1. A cowboy,	or, 2. A banker	( )
1. A pirate,	or, 2. An astronomer	( )
1. A cartoonist,	or, 2. A judge	( )
1. A mail carrier,	or, 2. A dentist	( )

1. A fireman,	or, 2. A newspaper reporter	( )
1. A wireless operator,	or, 2. A truck driver	( )
1. A machinist,	or, 2. A king	( )
1. An electrician,	or, 2. A knight	( )
1. A soldier,	or, 2. A railroad engineer	( )

1. An author,	or, 2. A mail carrier	( )
1. An acrobat,	or, 2. An electrician	( )
1. A poet,	or, 2. An ice man	( )
1. An Indian,	or, 2. A carpenter	( )
1. A jeweler,	or, 2. A scientist	( )

1. A cowboy,	or, 2. A newspaper reporter	( )
1. A doctor,	or, 2. A policeman	( )
1. A king,	or, 2. A congressman	( )
1. A bookkeeper,	or, 2. An acrobat	( )
1. A circus performer,	or, 2. A cartoonist	( )

1. A builder,	or, 2. A chauffeur	( )
1. A civil engineer,	or, 2. A soldier	( )
1. A truck driver,	or, 2. A business man	( )
1. A knight,	or, 2. A clergyman (priest or minister)	( )

TEST 3

"Books to Read"

In each pair choose the book which you would like better to read

Would you rather read:

1. The Stampede, or, 2. Treasure Island ( )
1. Robinson Crusoe, or, 2. The Boys Book of Automobiles ( )
1. Apank, the Indian boy, or, 2. The Gold Rush ( )
1. The Burning Fountain, or, 2. Cowboys and Indians ( )
1. Uncle Wiggley Stories, or, 2. Pee Wee Harris' Funny Bone Hike ( )

1. Danger Ahead, or, 2. Over There ( )
1. The Freshman Hero, or, 2. The Knight of the Silver Sword ( )
1. Gentlemen of Courage, or, 2. The Cruel King and the Magic Ring ( )
1. The Honor of the Clan, or, 2. The Sunbonnet Babies in Holland ( )
1. Bunny Rabbit's Friends, or, 2. Meaning No Offense ( )

1. Sherlock Holmes, or, 2. The Black Wolf Pack ( )
1. Robin Hood, or, 2. The Greenwich Manor Mystery ( )
1. Captains Courageous. or, 2. With the Indians in the Rockies ( )
1. Peter Pan, or, 2. Rex, a Collie ( )
1. The Knight and the Dragon, or, 2. Tom Patterson's Forward Pass ( )

1. The Pirate Prince, or, 2. Where Men are Men ( )
1. Dauntless Heart, or, 2. Fairy Tales of Many Lands ( )
1. Uncle Wiggley's Friends, or, 2. Steel of the Royal Mounted ( )
1. Dan's Great Adventure, or, 2. Cowboys and Indians ( )
1. Peter Rabbit, or, 2. Wrongly Accused ( )

1. The Ninth Inning, or, 2. The Indian Trail ( )
1. The Girl from Rio, or, 2. Our Little French Cousins ( )
1. Sonny Boy, or, 2. The Great Divide ( )
1. The Pride of the Fleet, or, 2. Danny Brown in the Indian Camp ( )
1. The Avenger, or, 2. Wild Animals At Home ( )

1. Grimm's Fairy Tales, or, 2. The Girl with the Golden Hair ( )
1. Out to Win, or, 2. Dog Heroes from Many Lands ( )

TEST 4

"Things to Have"

In each pair choose the thing which is more fun to have

Is it more fun to have:

1. Some handkerchiefs, or, 2. A set of toy soldiers ( )
1. A pet rabbit, or, 2. A punching bag ( )
1. A wagon, or, 2. A tennis racket ( )
1. A watch, or, 2. A Scout suit ( )
1. An Indian suit, or, 2. A pair of kid gloves ( )

1. A magic set, or, 2. A camera ( )
1. A new hat, or, 2. A blackboard ( )
1. *A box of writing paper, or, 2. A toy engine* ( )
1. A swimming suit, or, 2. A moving picture machine ( )
1. A cowboy suit, or, 2. A set of golf clubs ( )

1. A brush and comb, or, 2. A drum ( )
1. An Indian suit, or, 2. A wallet ( )
1. A fountain pen, or, 2. A pair of rubber gloves ( )
1. An electric train, or, 2. A book of detective stories ( )
1. A toy wagon, or, 2. A silk handkerchief ( )

1. A bow and arrow, or, 2. A book of sport stories ( )
1. A new shirt, or, 2. A set of building blocks ( )
1. A printing press, or, 2. A suit of clothes ( )
1. A necktie, or, 2. Some marbles ( )
1. A magic lantern, or, 2. A saxophone ( )

1. *A suit of clothes, or, 2. A toy steam engine* ( )
1. A pair of rubber boots, or, 2. A baseball glove ( )
1. A toy boat, or, 2. A new hat ( )
1. A model airplane, or, 2. An electric train ( )
1. A kite, or, 2. A new pair of shoes ( )

1. A pet rabbit, or, 2. A sweater ( )
1. A book of adventure stories, or, 2. A water pistol ( )
1. A brush and comb, or, 2. A drawing set ( )
1. A croquet set, or, 2. A toy cannon ( )
1. *A pet kitten, or, 2. An album* ( )

1. A wallet, or, 2. A toy auto ( )
1. A blackboard, or, 2. A necktie ( )
1. Some handkerchiefs, or, 2. A school bag ( )
1. A pet canary, or, 2. A pair of sport socks ( )
1. A toy boat, or, 2. A traveling bag ( )

1. A toy tractor. or, 2. A tennis racket ( )
1. A pet dog, or, 2. A Scout suit ( )
1. A Meccano or Erector Set, or, 2. A book of sport stories ( )
1. A raincoat, or, 2. Some goldfish ( )
1. A drum, or, 2. A box of candy ( )

TEST 5

"THINGS TO SEE"

In each pair choose the thing you would like better to see

Would you rather see:

1. A beautiful sunset, or, 2. A fairy prince ( )
1. Soldiers marching, or, 2. An auto accident ( )
1. Men digging ditches, or, 2. Men building a bridge ( )
1. An auto race, or, 2. Animals in the zoo ( )
1. A bakery window, or, 2. A chemist working ( )

1. A man getting arrested, or, 2. An auto factory ( )
1. The North Pole, or, 2. A fairy castle ( )
1. An artist painting, or, 2. A king ( )
1. A movie actress, or, 2. A giant ( )
1. A lot of Indians, or, 2. A banquet ( )

1. A parachute jumper, or, 2. An army camp ( )
1. A circus parade, or, 2. A trial in court ( )
1. A diving exhibition, or, 2. A stage coach ( )
1. A giant, or, 2. Girls playing basketball ( )
1. A fort, or, 2. A boxing match ( )

1. A blacksmith working, or, 2. A musical comedy ( )
1. A pretty girl, or, 2. A castle ( )
1. A magic carpet, or, 2. A diving girl ( )
1. A track meet, or, 2. Someone falling on the ice ( )
1. Cowboys on a ranch, or, 2. A movie studio ( )

1. A parachute jumper, or, 2. A steamshovel ( )
1. A chemist working, or, 2. A knight ( )
1. Fire engines, or, 2. A motorboat race ( )
1. A chemical laboratory, or, 2. Soldiers marching ( )
1. A riot, or, 2. A fairy castle ( )

1. Santa Claus, or, 2. A fancy dress ball ( )

Test 6

"Things to Think About"

In each pair choose the thing you like better to think about

Would you rather think about:

1. Traveling in Europe, or, 2. Cowboys on a ranch ( )
1. Ghosts, or, 2. The men at West Point ( )
1. Boy Scouts, or, 2. Famous athletes ( )
1. Success in life, or, 2. Things you saw at the movies ( )
1. Magic things, or, 2. Home ( )

1. Wild Indians, or, 2. Being a famous man ( )
1. College life, or, 2. Pirates ( )
1. Radio, or, 2. The funny paper ( )
1. Hikes in the woods, or, 2. The days when knights lived ( )
1. Heroes of long ago, or, 2. Men at Annapolis ( )

1. Pretty girls, or, 2. Giants ( )
1. Knights and dragons, or, 2. The girls you have met ( )
1. Famous men, or, 2. Eating candy and ice cream ( )
1. The Wild West, or, 2. Criminals and detectives ( )
1. Wild animals, or, 2. Going traveling ( )

1. Magic things, or, 2. Being popular ( )
1. Automobiles, or, 2. Eating candy and ice cream ( )
1. The funny papers, or, 2. The books you have read ( )
1. Civil engineers, or, 2. Savages in the jungle ( )
1. Wild Indians, or, 2. The jokes people tell you ( )

1. Airplanes, or, 2. Hunting in Africa ( )
1. Success in life, or, 2. The things you like to eat ( )
1. Giants, or, 2. The funny things you have seen ( )
1. Getting a job, or, 2. The days when knights lived ( )
1. Famous athletes, or, 2. Dogs and other pets ( )

1. The Wild West, or, 2. Your mother and father ( )
1. Playing baseball and other games, or, 2. Cowboys on a ranch ( )

the pair he was instructed to place the figure *1* in the parentheses at the right. If he preferred the second item in the pair he was to write the figure *2*.

It was feared at first that this simplified scoring system might result in a lowered reliability. To determine this point Test 2 of the preliminary scale in the old form was given to 94 boys in one grammar school. These same boys were also given the same items rearranged in accordance with the new method of paired comparisons. Precautions were taken to equalize the effect of priority of presentation. The reliabilities of the two methods were then computed by the method of split halves and it was found that the method of paired comparisons yielded a reliability of .73 whereas the old method of weighted items yielded a reliability of only .64. The new method therefore was not only much simpler than the old but actually yielded better reliabilities. It is suggested that this method of paired comparisons may have a general usefulness in the field of personality and behavior tests.

The next step was the selection of items. It was decided that each pair should consist of an item which showed increasing popularity with age and an item which showed decreasing popularity. Moreover the two items should increase and decrease in such a way that the graphs representing this increase or decrease should cross each other at about the middle of the age range. To select good pairs of items it therefore became necessary to know how children's preferences in regard to a large number of items increased or decreased with age.

For this purpose many data were available from the work on the preliminary test. Further material was gathered by presenting a large number of items to the boys in one grammar school asking them to express their preferences. The results of all these experiments were graphed and paired items were selected on this basis. It is to be noted that a certain amount of arbitrariness was legitimate at this point because the selection of items was to be tested out subsequently. The worst effect, therefore, of a poor selection of items would be that these items would later have to be dropped.

Finally 224 pairs of items were selected. The scale in this form was given in May 1930 to 982 grammar- and high-school boys from age 8 to age 18. Of these, 584 were from Cleveland, 277 from Detroit, and 121 from Washington, D.C. The responses to each pair of items were tabulated separately for each age. Thus it was possible to see whether the responses to each pair showed a marked tendency to change with age. Pairs which received about the same sort of response throughout the whole age range were, of course, discarded as not being diagnostic. Answers which increased in frequency with increasing age were scored *plus* and those which decreased with increasing age were scored *minus* so that a higher score would characterize the older age-groups. Out of the 224 items in the original test only 28 pairs were discarded as being unsatisfactory, leaving 196 pairs in the final test.

After discarding the 28 pairs just mentioned a scoring key was constructed and the papers were scored. Since there were 196 pairs of items, the highest possible score would be 196. In the course of the scoring 29 papers had to be discarded because they were incomplete. The results of the scoring of the remaining 953 papers are shown graphically in figure 1 while the mean scores by ages are given in

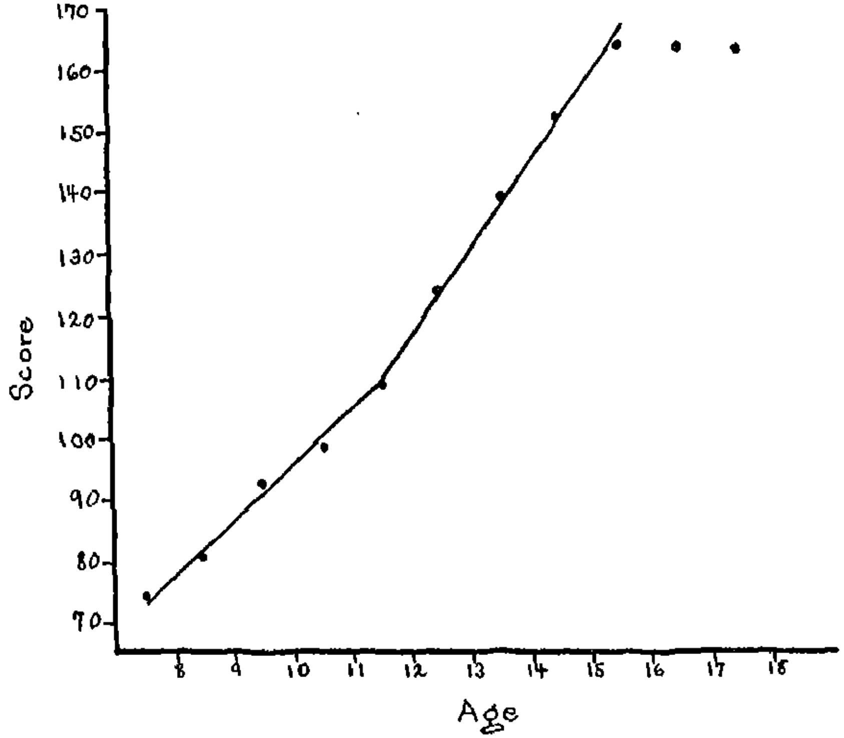

FIG. 1. RELATION BETWEEN SCORE AND CHRONOLOGICAL AGE

table 1. In this table and the other tables in this article "age 8" refers to boys who have passed their eighth birthday but who have not yet reached their ninth birthday.

It will be noted that scores increase quite regularly from age 8 to age 12, then more sharply from age 12 to age 16. After 16 there is no tendency to increase. It is a tempting theory that the acceleration in developmental age after 12 is due to the dawn of adolescence. The phenomenon may, however, be due to factors of selection since the boys in the older age-groups were largely high-school boys who may not be typical of the entire boy population. It is interesting also to notice that developmental age does not increase with chronological age after 16. In this, it resembles Binet mental age. Here again, however, factors of selection may be at work. It is possible that the more mature boys had left high school after reaching their eighteenth birthday.

TABLE 1

Mean scores by ages

AGE	N	MEAN SCORE
8	30	73.33
9	91	80.74
10	99	92.09
11	124	98.30
12	127	108.40
13	99	122.90
14	114	138.20
15	105	152.26
16	79	164.27
17	55	163.04
18	30	162.66
Total......	953	

RELIABILITY AND VALIDITY

The reliability of the test was computed on the basis of the entire group of 953 individuals. Since reliabilities are spuriously raised when they are computed over a considerable age range it was decided to compute coefficients separately for each age group. The elimination of the effect of chronological age in this manner is a very severe test of the reliability of the scale and one which is often neglected. The resulting reliabilities are given in table 2. It will be noted that they do not fall below .85 at any age and that the mean reliability of the single age-groups is equal to .91. The size of these correlations was one of the happiest surprises of the present investigation.

TABLE 2

Reliability of the revised scale in separate age groups

AGE	N	RELIABILITY
8	30	.85
9	91	.87
10	99	.89
11	124	.90
12	127	.92
13	99	.94
14	114	.93
15	105	.94
16	79	.94
17	55	.96
18	30	.92
Mean....................		.91

It is less easy to estimate the validity of the test because there is no ready criterion of developmental age. In the preliminary scale validity was estimated by correlating test results with ratings obtained from a rating scale. In the present instance, however, it was felt that this procedure would not be entirely satisfactory because the validity of even the best rating scales is very much subject to question. It is doubtful whether it would be possible to construct a criterion which would be more valid than this test itself. Chronological age would be a very rough criterion. It yielded a coefficient of .82 when correlated with test results over the entire range from age 8 to age 18. This means little more than that there is considerable spread in developmental age in each age-group. The best available answer to the question of the validity of the present scale (and it is admittedly an unsatisfactory answer) is given by the fact that the present test is evidently based on preferences concerned with types of play, books, fantasies, ambitions, and the like. But preferences of this sort are precisely what we mean by the term "developmental age."

RELATION OF DEVELOPMENTAL AGE TO OTHER FACTORS

It seems probable that the scores of the present test are not greatly affected by differences of intelligence. In the work on the preliminary test a partial correlation of .23 (age constant) was found between developmental age and the results of a group intelligence test (Haggerty Delta-2). A correlation of −.15 was found between developmental age as measured by the rating scale previously mentioned and the same test results. The mean of these two coefficients is .04 (4, p. 20). Lawlor (8) working with a group of mental defectives in whom differences of mental age were striking reported correlations of .35 between developmental age and Stanford-Binet, −.04 between developmental age and Porteus Maze, .13 between developmental age and Healy 2, and .70 between developmental age and the Goodenough Drawing Test. Since, however, Lawlor's group showed a large age range (9 to 25 years) and since the correlation of developmental age and chronological age in this group amounted to .45, it is probably true that partial coefficients of correlation (age constant) would have shown little relation between developmental age and the mental tests mentioned.

In the case of the present revised scale, unfortunately, mental test data were lacking for most of the subjects. For a group of 35 boys at age 14 a coefficient of −.12 was obtained. This was the only age group in which enough mental test data were present to secure a significant correlation. For 66 boys between age 12 and age 16 a partial correlation (age constant) of −.08 was obtained. By "mental age" in this paragraph score on the Cleveland Classification Test is meant. The conclusion to be drawn from these data is that there is no demonstrable relationship between developmental age and intelligence.

In the work on the preliminary scale (4) partial coefficients (age constant) of .22 and .16 were obtained between developmental age and weight and height respectively. Miss Zalduondo (9) obtained a correlation of .206 between height and developmental age on the preliminary scale for a group of 43 boys in grades 7 and 8, and a correlation of .362 for developmental age and weight. These same measurements, however, yielded zero or negative coefficients in grades 4 and 5. A considerable number of other physical measurements employed by Miss Zalduondo showed no clear and definite relationships with developmental age.

In the present study with the revised scale it was possible to investigate the question more thoroughly. The accompanying table 3 gives the results. Average coefficients of .09 and .10 were obtained for the correlation with height and weight respectively. A closer analysis of this table will show the reader that this degree of relationship is due principally to the correlations obtained after age 12. In the lower ages there is practically no correlation between developmental age and physical measurements. The explanation probably is that after this age adolescence enters as a factor. The adolescent boys in each age group tend to be taller and heavier than the rest of the population and also to have a higher developmental age. The whole question of the relationship between physical traits and developmental age calls for further investigation.

TABLE 3

Correlation of developmental age with height and weight in separate age groups

AGE	N	CORRELATION WITH HEIGHT	CORRELATION WITH WEIGHT
8	29	−.07	−.03
9	60	.00	.02
10	53	.03	.10
11	62	.05	.15
12	87	.12	.05
13	57	.16	.14
14	56	.27	.35
15	26	.20	−.02
Mean.		.09	.10

In order to make practical use of the test it was necessary to calculate developmental age equivalents for each score. This was done by fitting a line graphically to the data as shown in figure 1 and then interpolating. Extrapolation was also used for about one year below and one year above the actual range covered. The results are given in table 4. These figures are presented with considerable hesitation and the reader should so accept them. Attention is called also to the fact that an artificial meaning is given to the term "developmental age" by extrapolating above age 16½. This is precisely parallel to the use of Binet mental ages over age 16. According to the theory on which the Stanford-Binet is based there is no growth in mental age in the average individual beyond the sixteenth birthday. A mental age of 17 on the Stanford-

TABLE 4

Developmental age equivalents of specified scores

SCORE	D.A.		SCORE	D.A.	
	yrs.	*mos.*		*yrs.*	*mos.*
65	7	8	125	13	8
70	8	3	130	14	0
75	8	9	135	14	4
80	9	4	140	14	8
85	9	11	145	15	1
90	10	5	150	15	5
95	11	0	155	15	9
100	11	7	160	16	1
105	12	1	165	16	5
110	12	7	170	16	9
115	13	0	175	17	2
120	13	4	180	17	6

Binet, therefore, does not refer to the mental level of the average 17-year-old. It is an arbitrary designation for a level of mental ability which is 12 "mental months" above the 16-year level. Developmental ages over 16½ are to be understood in the same arbitrary sense.

CONCLUSIONS

1. The present test is a revision of a previously published test for developmental age. The previous test suffered from two particularly troublesome defects. Its scoring system was cumbersome and its reliability was low.

2. The first defect was overcome by the "method of paired comparisons" which not only made the test very much easier to score but actually yielded a considerable increase in reliability.

3. The second defect was overcome by the lengthening of the test and by a more careful selection of items. Reliabilities on single age groups ranged from .85 at age 8 to .96 at age 17 with a mean reliability of .91.

4. Evidence is presented to show that developmental age has little if any relation with mental age. It apparently has a slight positive relation with physical measurements but only after age twelve.

5. Developmental age equivalents are presented for the interpretation of test scores. These are based on the results of 953 tests administered in three cities.

REFERENCES

(1) FURFEY, PAUL HANLY: Developmental age. Amer. Jr. Psychiatry, 1928, 8, 149-57.

(2) FURFEY, PAUL HANLY: Developmental age. Cath. Educ. Rev., 1930, 28, 550-53.

(3) FURFEY, PAUL HANLY: The growing boy; case studies of developmental age. New York, The Macmillan Company, 1930, viii, 192 p.

(4) FURFEY, PAUL HANLY: The measurement of developmental age. Washington, Catholic Education Press, 1928, 40 p. (Catholic University of America Educational Research Bulletins, Vol. II, no. 10.)

(5) FURFEY, PAUL HANLY: A project in developmental psychology. Report of Character Education Research Conference held at the Chicago Theological Seminary under the auspices of the Religious Education Association, 1928, pp. 67-82.

(6) FURFEY, PAUL HANLY: A scale for measuring developmental age. Mental Hygiene, 1930, 14, 129-36.

(7) FURFEY, PAUL HANLY: Some preliminary results on the nature of developmental age. Sch. and Soc. 1926, 23, 183-84.

(8) LAWLOR, GERALD W.: Developmental age in feeble minded boys. New York, Columbia University, 1930, typewritten, pages not numbered (M. A. dissertation).

(9) ZALDUONDO, CELESTINA: A study of the relation between developmental age and some physical measurements. Washington, Catholic University of America, 1930, 33p. typewritten (M. A. dissertation).

Strength of Child's Grasp in Complicated Responses

BUFORD JOHNSON AND MAY WILSON

THE following is a report of a further study of the individual differences in children under five years of age in the pressure exerted in grasping during performances requiring coördinated hand movements. A previous investigation (1) showed wide differences among adults and children in the tension of the fingers during tapping movements. Simple and complicated forms of tapping were used. Efficiency of performance appeared to be related to the tension, within limitations of the length of time the tapping was continued. The children were required to tap 30 seconds and the adults 1 minute.

The present investigation was made to study the pressure variations of children with prolonged periods of tapping. Analysis has been made of the changes in the pressure from a simple tapping movement to a more complicated form for one minute periods, and for the complicated tapping prolonged to two minutes.

The apparatus used was the same as that described in the previous article (1). It consisted of the Dunlap Tapping Board and a stylus permitting pneumatic registration of the pressure exerted in grasping the stylus. The reactors were seated during the performance. Records were taken of five types of tapping, each type being performed on a different day, according to the following schedule: (1) Tapping 1 minute on a single plate, called "simple" tapping. The taps were recorded by magnetic counters. (2) Tapping 1 minute, first on the right plate and then on the left, called "complicated" tapping. The taps were registered on magnetic counters. (3) Simple tapping for 1 minute with the pressure stylus. A kymographic record was made of the taps, of the time in seconds and of the pressure of grasping. (4) Complicated tapping for 1 minute, with kymographic record. (5) Complicated tapping for 2 minutes, called "prolonged" with kymographic record. The right hand was used first, and after an interval sufficient for adjusting the drum the left hand was used in a similar manner. The recording apparatus was screened from view.

A more accurate method of scoring the pressure variations was employed in this investigation than in the first study. The area included between the pressure curve and the base line of zero pressure for the ten second periods was measured in square inches with a planimeter. The length of each ten second period was measured in inches. The average height of the pressure curve during each period was calculated by dividing the area by the length of the interval. The maximum height attained by the pressure curve during each interval was measured and recorded.

Twenty children formed the group that we intended to test. The tests on the children under two and one-half years were not completed as the measurements did not seem comparable. The pressure stylus is not as sensitive to the light grasp, but if the thinner rubber tubing were used the older child had a strong enough grasp to touch the central metal rod. Further work on this problem may give a stylus suitable for the different ages, though it appears now that different sizes of the stylus should be used. In several cases the children were not available for completing the series, and the number for which results are given is eleven.

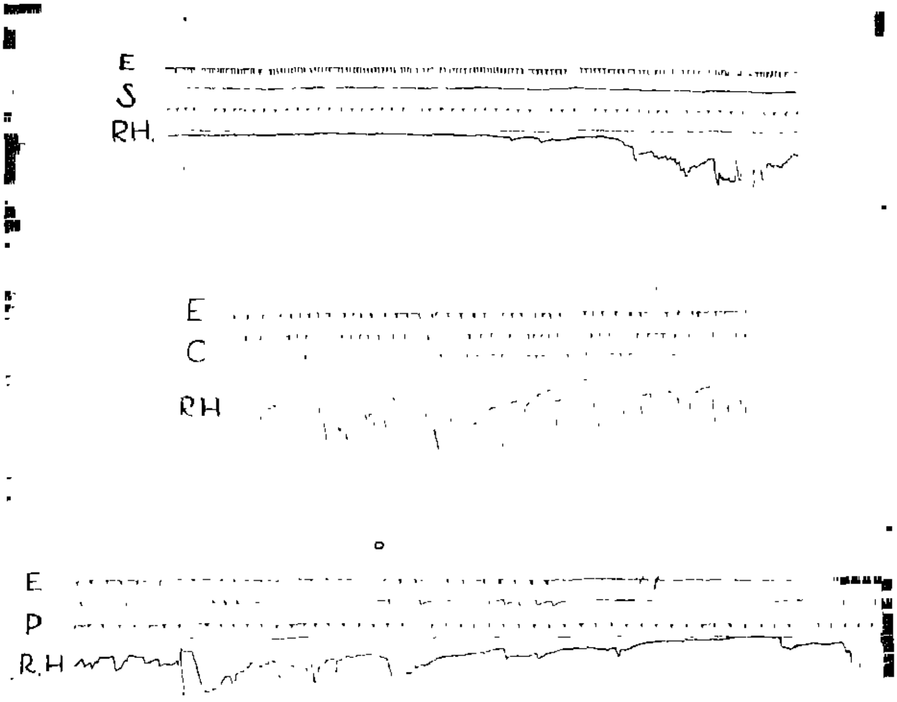

PLATE I. REPRODUCTION OF KYMOGRAPHIC RECORD FOR SUBJECT E SHOWING INCREASED PRESSURE WITH COMPLICATION OF RESPONSE

The analysis of the individual records is made with reference to the type of pressure curve, and to the changes in type for simple, complicated, and prolonged movements. These changes are also related to the efficiency of performance as measured by the total number of taps and the accuracy in the coördination of movements during

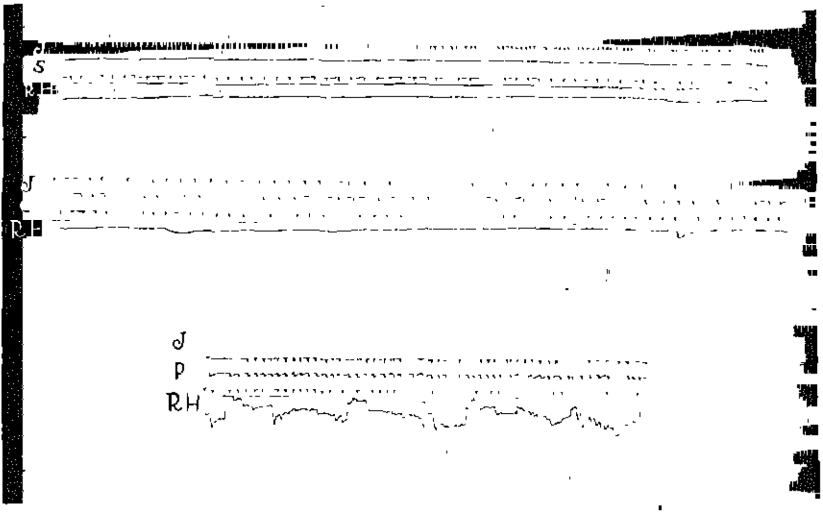

Plate II. Reproduction of Kymographic Record for Subject J Showing Increase and Variability in Pressure for Prolonged Tapping

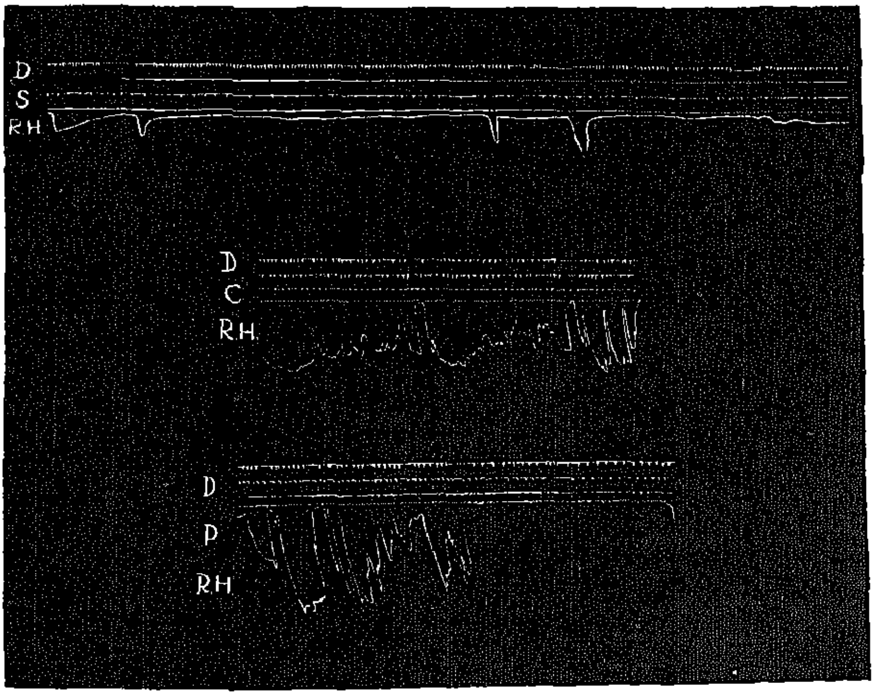

Plate III. Reproduction of Kymographic Record for Subject D Showing Erratic Pressure Variations and Increase with Complication of Response with Final Decrease

alternate tapping. Comparisons of the performances were made by means of rank orders under the different conditions.

Typical kymographic records are reproduced in Plates I, II, and III. In all cases these records were made with the right hand. The graphs shown in Plates IV and V were drawn from the measurements of the pressure curves. The ordinates of the graphs represent the ten second intervals, and the abscissae represent the average height of the pressure curve for the interval.

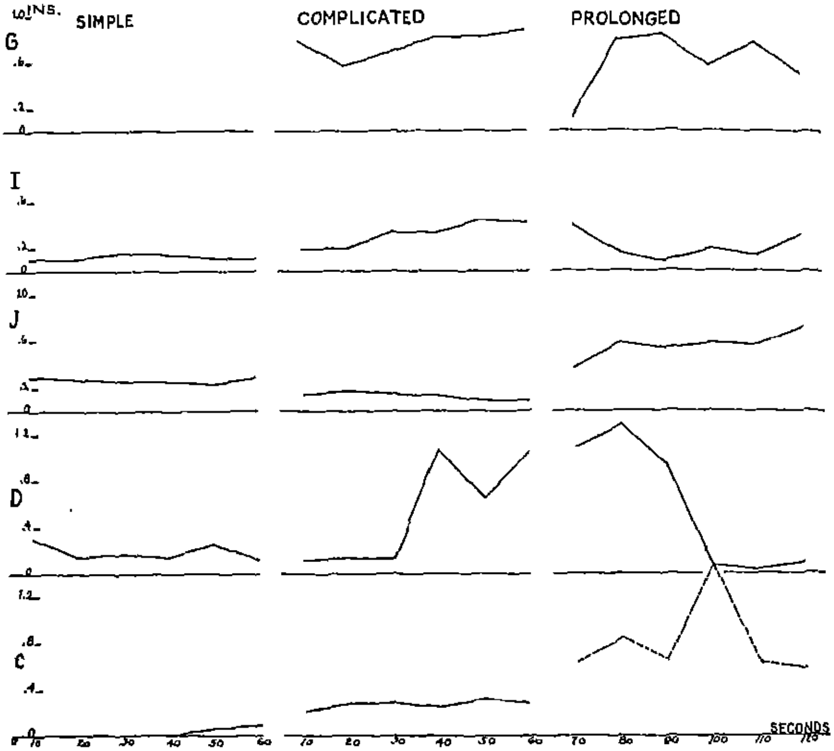

PLATE IV. GRAPHS FOR INDIVIDUAL CHILDREN SHOWING VARIATIONS IN PRESSURE FOR DIFFERENT TYPES OF PERFORMANCE DURING 1 MINUTE PERIODS OF TAPPING

Average height in inches for 10 second intervals are used in plotting the curves

The scores in table 1 give the average pressure for each child for 1 minute for each form of tapping.

When we compare the pressure records for the different performances we find 4 children who tend to high pressure for all forms of tapping; 3 children who show slight pressure in simple tapping but increase with the *complicated* and *prolonged tapping.* Child C showed the lightest pressure of the group in simple tapping but in rank order for the group changes from sixth place to tenth place in the succeeding forms. Other children show variations of only a few points in relative standing with regard to pressure. One child used greatest pressure in simple tapping which may be due to an apprehension often manifested by some children when a novel situation is presented.

fairly constant pressure. These forms of pressure variations are shown in the plates.

Group averages of the pressure for the different forms of tapping show an increase from the simple form to the complicated, and a further increase for the prolonged complicated tapping.

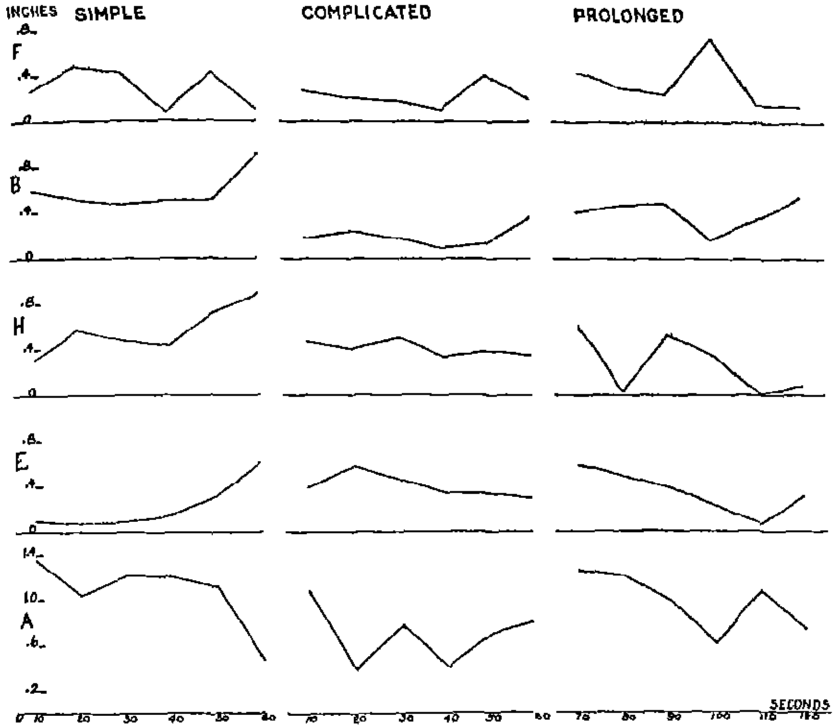

PLATE V. GRAPHS FOR INDIVIDUAL CHILDREN SHOWING VARIATIONS IN PRESSURE FOR DIFFERENT TYPES OF PERFORMANCE DURING 1 MINUTE PERIODS OF TAPPING

Average height in inches for 10 second intervals are used in plotting the curves

Within a tapping period for a given form some children show the increase in pressure toward the end of a one minute period of tapping. Others begin with high pressure and decrease. Some children are erratic or maintain

When the changes in rank order are considered, the greatest average change is from the complicated to the prolonged tapping. The averages obscure the extent of the change.

It is difficult to represent with

TABLE 1

Mean pressure scores for ten-second periods of tapping for individual children

	AVERAGE HEIGHT						MAXIMUM HEIGHT						RATIO					
	Right hand			Left hand			Right hand			Left hand			Right hand			Left hand		
	Simple	Complicated	Prolonged	Simple	Complicated	Prolonged	Simple	Complicated	Prolonged	Simple	Complicated	Prolonged	Simple	Complicated	Prolonged	Simple	Complicated	Prolonged
A	1.067	.697	.978	1.406	1.328	.625	1.293	1.428	2.143	2.128	2.472	1.620	1.324	2.148	2.302	1.848	1.894	3.187
B	.593	.202	.398	.105	.216	.22	.835	.38	.898	.270	.400	1.055	1.481	2.058	2.505	1.878	1.811	4.67
C	.025	.268	.8	.184	.432	.548	.032	.403	.153	.248	.498	1.553	1.25	1.51	2.026	1.269	1.216	6.605
D	.185	.88	.577	.593	1.085	.582	.35	1.427	1.605	.902	2.618	1.32	2.633	3.056	9.236	1.571	2.535	2.737
E	.217	.393	.342	.305	.412	.323	.532	.795	.612	.583	.610	.442	3.858	2.08	2.048	1.962	1.486	1.347
F	.277	.245	.338	.476	.873	.251	.875	.428	.735	.850	1.290	.47	2.631	1.566	3.156	1.646	1.376	1.881
G	.000	.753	.785	.126	.247	.435	.000	.978	1.253	.180	.342	1.01	.000	1.3	1.66	1.565	1.38	2.42
H	.558	.412	.272	.546	.479	.745	.810	.863	1.33	1.210	1.060	1.75	1.458	2.136	3.238	2.283	2.177	2.431
I	.115	.313	.208	.198	.154	.195	.425	.838	.652	.268	.223	.262	3.263	2.578	3.238	1.365	1.383	1.419
J	.267	.133	.372	.208	.154	.386	.278	.177	.643	.242	.223	.925	1.045	1.369	1.758	.811	1.57	3.147
K	.517	.620	.215	.645	.368	.308	.935	1.032	.333	1.215	.682	.592	1.863	1.944	2.063	1.929	2.136	1.998

numbers *the characteristics* of a curve. *For example, a pressure curve for a* ten second period of tapping may include *one* or more than one high *pressure* points. In giving the pressure for such a ten second period a numerical value of the average height of the curve does not furnish an adequate *picture, nor does the maximum height.* The ratio of the maximum height to the average height seems to have value in representing such raggedness and irregularity of a curve. This ratio has an additional value in being independent of the magnitude of the pressure measurements. That is, it has the same significance in the case of a high pressure curve as in the case of one of low pressure. We have calculated these ratios for the various ten second periods and have found that they indicate a type of behavior which has been observed in tapping as well as in other performances in both children and adults, *that is, a tendency to over* compensate when the work becomes less efficient. In tapping this compensation usually results, not in the subject's actually tapping faster, but in his *tapping with more force. In* this laboratory children have worn down a hard metal stylus by this pounding, necessitating its being replaced.

In general, it has been noted that the pressure curves of the *prolonged tapping become more ragged* toward the end of the two minute tapping period. This results from the effort of the subject to maintain a high rate of tapping, in spite of the fact that muscular fatigue or other factors tend to slow it down. This increase in raggedness of the pressure curve is shown in table 2 by an increase in the *ratio* from the first ten second interval to the last ten second interval.

Similar data for the left hand show 7 *cases in which there is a* positive change, and 4 cases in which there is a negative change. The average positive change is *1.72* right *hand and* 1.173 left hand while the average negative change is 0.37 right hand and 0.169 left hand.

If instead of comparing the first and *twelfth ten second intervals, the average* value of the ratio for all reactors for the entire one minute period of the complicated tapping is compared to the *similar average for the second minute* of the prolonged tapping, the average *of the ratio for* the second minute is found to be greater than the average of the ratio for the first minute of tapping.

TABLE 2

Comparison of ratio measure of pressure for initial and final periods of tapping

Ratio score represents quotient of maximal height for a ten second period divided by the average height for that period.

SUBJECT	RATIO FOR 1ST TEN SECONDS	RATIO FOR FINAL TEN SECONDS	CHANGE
A	1.78	2.07	0.29
B	1.63	1.00	0.37
C	1.24	1.80	0.69
D	1.24	0.33	8.09
E	1.36	1.60	0.33
F	1.23	4.61	3.38
G	1.38	1.45	0.07
H	1.43	2.86	1.43
I	1.17	3.42	2.25
J	1.22	1.58	0.36
K	1.54	1.17	−0.37

Average ratio, first minute, complicated, right hand...... 1.075
Average ratio, second minute, prolonged, right hand 3.086

Average ratio, first minute, complicated, left hand............ 1.724
Average ratio, second minute, prolonged, left hand........... 2.890

With each hand there are only two individuals who changed in the reverse direction.

EFFICIENCY OF PERFORMANCE

There are wide differences in the number of taps made by individual children. Age differences for this test have been found in the many studies of tapping though greater overlapping of age groups appears as the age increases. In table 3 the number of taps made by each child in each form of tapping is given. The accuracy of performance is measured by the difference in the number of taps made on the right and left plates in the alternate tapping as given in table 4. The child having the smallest difference ranks first. When the rank orders in the number of taps for the two preliminary forms of tapping recorded by the magnetic counters are compared with rank orders recorded on the kymograph the following changes in rank occur: For simple tapping recorded on counter with simple tapping recorded on kymograph the arithmetic mean of the

TABLE 3

Tapping scores for one minute periods under different conditions

REACTOR	RIGHT HAND			LEFT HAND		
	Simple	Complicated	Prolonged	Simple	Complicated	Prolonged
A	205	116	93	155	120	79
B	168	114	92	155	94	80
C	168	135	132	204	136	130
D	166	138	123	169	122	105
E	153	89	55	123	69	82
F	149	102	94	136	97	96
G	144	137	116	154	115	116
H	142	101	80	149	110	89
I	131	89	79	135	75	52
J	131	98	82	114	74	69
K	100	99	71	135	83	82

TABLE 4

Tapping scores for each plate showing accuracy in coördination of movements

REACTOR	COMPLICATED—1 MINUTE								COMPLICATED—SCORE FOR LAST MINUTE WITH 2 MINUTES OF TAPPING							
	Right hand				Left hand				Right hand				Left hand			
	a	b	Difference	Total	a	b	Difference	Total	a	b	Difference	Total	a	b	Difference	Total
A	56	60	4	116	64	56	8	120	44	49	5	93	41	38	3	79
B	58	56	2	114	47	47	0	94	53	39	14	92	40	40	0	80
C	70	65	5	135	71	65	6	136	65	67	2	132	68	62	6	130
D	65	73	8	138	62	60	2	122	65	58	7	123	51	54	3	105
E	47	42	5	89	35	34	1	69	24	31	7	55	44	38	6	82
F	48	54	6	102	47	50	3	97	46	48	2	94	50	46	4	96
G	72	65	7	137	61	54	7	115	62	54	8	116	62	54	8	116
H	50	51	1	101	60	50	10	110	41	39	2	80	44	45	1	89
I	46	43	3	89	41	34	7	75	42	37	5	79	21	27	6	48
J	49	49	0	98	39	35	4	74	38	44	6	82	34	35	1	69
K	45	54	9	99	35	48	13	83	28	43	15	71	44	38	6	82

amount of change is right hand 2.5; left hand 2.2. For complicated tapping recorded on counters with complicated tapping recorded on kymograph the arithmetic mean of the amount of change is right hand 2.1; left hand 1.5.

The efficiency of performance as measured by the total number of taps decreases with the complication of movements and with prolongation of tapping period. The average number of taps for the group for the last minute of the two minute period was 92.4; for one minute of this complicated form the average was 110.8 taps, showing a difference of 18.4. In every case there was a decrease, but there were wide individual differences in the amount of decrease. The range of scores for the children in the one minute period was from 90 to 138, for prolonged tapping the range was from 71 to 132. In simple tapping the group average was 150.4 taps which is 39.8 more than in the complicated form.

When the efficiency is compared with the pressure scores greater changes in rank order occur than for other comparisons, the average change increasing as the task is prolonged or more complicated. Significant individual differences appear. The child who maintained highest pressure was the most efficient in total output and ranked fairly high in accuracy, which is measured by the difference in taps on the two plates. Another child with high pressure was efficient in total taps but only fair in accuracy. A child with low pressure scores was poor in tapping score. The efficiency appears to be more closely related to the type of curve within a given period of tapping than to the total pressure score.

Analysis of the behavior of these children in social relations shows that the children with high pressure records had difficulties in adaptation. Some who ranked low in efficiency but showed less than average pressure lack initiative ability in activities. They appear slow in action and deliberative rather than spontaneous. The scores in other tests of coördination of movement appear to bear out these conclusions. The Intelligence Quotient does not appear to have a direct relation to the tapping score.

SUMMARY

Those children who show initial high pressure relative to their average pressure and decrease the pressure during the performance appear to be more efficient. In some cases these children have a high total pressure but still maintain efficiency. Others show a lower pressure level in total but the curve of decrease is similar and efficiency is high. Children who show slight initial pressure but increase toward the end of the period may be efficient in the simple task for a brief period but when it is prolonged and the task is complicated their efficiency is greatly reduced. The child who shows erratic changes in pressure is rarely high in efficiency and often becomes inaccurate and falls into a low rank.

Previous study of a few adults showed that the person who maintained light pressure throughout was the most efficient but the reactor with high pressure in initial seconds with gradual decrease was almost as efficient. It may be that in such simple performances as the tapping test, the adult has attained an efficiency in movement through reduction of tension in fingers. A survey of past and current individual records tends to favor the second form of pressure as an indicator of efficiency.

It is probable that the pressure records could be wisely used in directing the young child's activities toward relaxation for some and alertness for others. The results of this investigation lead us to conclude that habits of reaction based upon temperamental tendencies may be studied to advantage by this method.

REFERENCE

(1) JOHNSON, BUFORD: Changes in muscular tension in coördinated hand movements. Jour. Exper. Psychol., 1928, 11, 329–341.

The Effect of Bodily Orientation upon the Young Child's Memory for Position of Objects*

L. Lucile Emerson

HISTORICAL SUMMARY

FOR some years spatial perception has been a topic of philosophical and psychological treatises. The bulk of the literature bearing upon this psychic factor deals with the theoretical nature of the problem, discussing the origin and growth of spatial perception. The fact that visual perception and spatial relationships are well organized in the adult is a very common observation. The determinations of the beginnings of such organization is a problem which can best be solved by the study of children. Very little work has been done on this topic. It is hoped that future investigations will be concerned with development of spatial perception and relationships in the young child as the past has been concerned with the adult status of these factors.

Various psychological theories of spatial perceptions have been advanced by eminent psychologists. The genetic theory supported by W. Wundt lies at one extreme, while the nativistic theory upheld by Herring and M. Von Frey presents the opposite point of view. The genetic idea is that perception of space is derived from the final fusion of sensations which in themselves are spaceless. This idea as expressed by Wundt is that "all spatial ideas are arrangements either of tactual or visual sensations." Opposed to this theory is that of the nativist who argues that all sensations have fundamental spatial characteristics. Wundt, in commenting upon the child's perception of space, expresses the belief that such perception is much less complete in the child than in many animals.

Titchener (13) advances a theory which he himself says is half-way between these two extreme theories. According to his reasoning, some sensations have a characteristic of spatial extent which make "localization of these sensations a necessary consequence of qualitative differences within total bi-dimensional fields." Furthermore, the visual perception of a place or position is highly organized in the individual; stimuli which have spatial differences are definitely placed in spatial relationships to one another.

P. Swindle (12) in reviewing Kaila says that the latter believes there is little foundation for a classification of individual's space perception into three dimensions, but that "each response has its own spatial attribute and its manifestation means perception of space in a particular form or dimension."

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* From the Institute of Child Welfare, The University of Minnesota. To Dr. Florence L. Goodenough who directed this problem and to Dr. John E. Anderson who offered many helpful suggestions I make acknowledgment of my indebtedness.

Pillysbury (10) in commenting upon perception maintains that perception as a whole is a much simpler problem than that of association. He believes that it is difficult for anyone to determine when perception and association are not united; for him the problem of perception is largely one of association. One of the best as well as one of the simplest definitions of perception given in psychological texts is that given by Woodworth (18) when he says that "perception is knowing the fact." Facts that are stimulating the eye are known as visual perceptions. These visual perceptions offer the data for the perception of spatial facts.

Perhaps the most comprehensive viewpoint of the conception of spatial relationships in the young child has been elaborated by Stern (11) and Koffka (7). These two men have endeavored to show how space perception has developed in the young child. Stern (11) says that even by first year there is a beginning of the conception of space. He uses the term the "conquest or mastery of space" to explain the growth of spatial perception in both ideas and actions. Here we have the mental and physical grasp of space going on simultaneously. Stern believes that psychology has long been laboring under the mis-conception that the mental and physical conception of space is entirely separated. This was perhaps due to the fact that most of the investigations that have been carried on were done with adult subjects. Stern's interest is also centered in the question as to whether spatial perception is native or acquired. This also he believes can be answered only by a study of child psychology. In this regard he says there is no act of perception of a familiarity with space in which both natural and acquired faculties do not take part. Koffka (7) also is interested in the child's conception of spatial relations. To the infant the objects which arouse reactions are those within his field of vision. In the young child this field of vision is confined to a very narrow range of space. He sees first only those things which are directly in front of him.

Actual experimentation that has been done in this field of spatial relationships is limited. Miss Williams (16) states that P. Meyer in 1919, carried out an experiment on memory for spatial position for oddly shaped figures or objects. Objects were presented in different positions of rotation toward the right, left, backward and forward. After a delay of twenty-four hours the observer was required to identify the position in which a given figure was originally presented. The results of this experiment yielded the following conclusions: (1) that there were various tendencies toward error, (2) that the errors were especially noticed in the identification of neighboring and symmetrical positions with the original, (3) that there was inability to determine degree of rotation though the direction was correctly given.

S. R. Court (3) studied the development of number time and space concepts in a child from twenty months to five years of age. At two years of age a spontaneous interest in numbers was observed. At the age of three years 5 months the boy could count to twelve; and at 4 years 3 months he could count to 100. Conception of time was first manifested at 20 months in the child's preference for simple stories in which the verbs were all in the same tense. He understood the future tense at 2 years, knew the seasons at 4 years, and could tell time at 4 years 10 months. His first inclination to measure space was at 2 years 10 months when he measured one object in relation to another. At 3 years he could appreciate space and distinguish between objects of different size. The subject's sense of orientation was good at 2 years at which time he knew his way home from four directions each two or three blocks distant. At 3 years he knew the location of three inter-urban stations and the relation of each to his home. Interest in "near" and "far" was apparent by 4 years. In conclusion, Court states that interest in space in some of its phases was less spontaneous than interest in time and number. Space measurement was influenced by external conditions many times. She concludes that, "growth of this child's appreciation of space and of his sense of orientation is as natural as is the growth of his body."

Aside from those experiments dealing with static equilibrium, comparatively very little work has been done in respect to the ability of an individual to maintain his sense of position or bodily orientation. The ability of the individual to maintain his normal bodily position and spatial relationships in reference to the surroundings is spoken of in psychology as "orientation." This is a factor so closely tied up with space perception that it also merits a closer treatment.

The best psychological definition of bodily orientation is probably that one given by J. M. Baldwin (1) in his dictionary of psychological terms when he defines bodily orientation as "the undisturbed consciousness of the spatial relationships of the body as a whole to its surroundings." He affirms that the orientation of a body to its surroundings is conditioned by many factors such as factors of sense, number, visual sensations, cutaneous sensations and auditory sensations. Orientation of body becomes reflexive and only comes into consciousness when it is disturbed.

Stern (11) deals with a child's sense of position. Both mathematically and psychologically the individual's conception of space must begin from a definite center. In mathematics this center is any arbitrarily assigned point, but in psychology, space center has only one position and that is "in the person of the perceptive individuality." That is every man is the center of his own space and his dimensions of right or left, up or down, backward or forward, are in relation to his own body. All things then in the external field of space are brought into some relative position with individual space. According to Stern the young child does not completely master his individual space before he masters the concept of outer space. These two conquests of space go hand in hand. The child has a consciousness of the sense of position. The vestibular activities and the semi-circular canals of the inner ear help in knowledge of sense of position.

Koffka (7) in his discussion of the sense of position says that the infant's field of vision is limited, so that he sees only those objects which are before him and not those which appear at one side, above or below. He says, "to the child form is much more independent of spatial position that it is to adults." To support this contention Koffka cites the ability of children to recognize pictures even though the pictures are turned at angles varying from ninety to one hundred eighty degrees. In adults however, the recognition is dependent upon the absolute orientation of the figure. To the adult, "right, left, above and below become characteristic properties of the different members of configuration and consequently of the total form." As Koffka suggested children's perception of sense of position would be of sufficient significance to justify painstaking investigation.

Baldwin and Stecher (2) in their explanation of the adaptation board used in experimentation with young children state that the ability of an individual to adapt himself to a changed situation is known to correlate highly with intelligence. In tests using the adaptation board, the degree of success attained by the child depends to a great extent upon attention and observation of the experimenter's movements and ability to remember them. The most important factor in the whole test is the ability to visualize a new position of the board in relation to the old. In reference to adaptation of the body to a new position, Janet makes this statement—"the reversal of position in visualizing of situation could account for the certain illusions of orientation."

Trowbridge (14) has formulated two methods of orientation which he calls ego-centric orientation and domi-centric orientation. The ego-centric is that method which is generally used by civilized man. In this there is an intersection of lines at the ego going out to the cardinal points of direction. That is, a man's own body is his center for all space. The domi-centric is a method used by birds, mammals, fish, and even young children whereby orientation is established with reference to some external object which is usually the "home." How ever, the orientation system which man uses is very complex and is probably a combination of both of these two methods. The consciousness of "body sense position" has arisen gradually to the final form found in adults. Yet it should not be considered an innate faculty but one that is furnished by the sum total of various senses.

Trowbridge states that birds because of the phenomena of lateral vision have an advantage over man in the maintaining of bodily orientation. The bird as it moves through unfamiliar space depends on the subconscious summing up of space relations which are immediately about it. He says that the importance of lateral vision to near-by orientation has not heretofore been properly emphasized. Williams (17) in discussing Trowbridge's article says: "Distance is judged by relative displacement. This should be considered in any theory of orientation implying a sense of direction."

Closely related to these problems of spatial perception and bodily orientation are the experiments which have been carried on with the purpose of studying the delayed reactions of animals and children. Hunter (5) states that the delayed reaction problems can be solved in two ways: "By maintenance of bodily orientation in whole or in part during the interval of delay or by the chance recovery of the proper orientation just at the moment of release; or by some intraorganic factor (non-orientation) non-observable to the experimenter."

If the animal solves the problem by the first method he is responding in agreement to his bodily orientation but if he solves it by the second method it is not in agreement with orientation.

In the experiments which Hunter carried out he kept a detailed record of the direction in which the animal in the problem box was orientated. The release box in which the animals were released was large enough so that the animals were free to take up any position and maintain a certain bodily orientation. He states that in no case where an animal depended upon use of orientation as a cue, did he begin the use of non-orientation factors for cue. Hunter's experiments show the following results in regard to orientation:

Rats in order to make the correct responses must maintain gross bodily orientation. If the bodily orientation is lost, any of the lighted boxes may be entered. Dogs follow the orientation of the head making the correct responses regardless of which box is nearest. Racoons made two types of responses: (a) Several made correct reactions when bodily orientation was the cue for the response; (b) Some other raccoons made correct response in which bodily position did not enter as a cue for the response. In these cases some intra-organic factor (non-orientation) must have been responsible for the reaction. Children made correct response where bodily position was not kept constant during the interval of delay and therefore solved the problem by some other means which Hunter believes were of an ideational nature.

Although spatial perception has been treated in psychological discussions since the beginning of psychology, not very much experimental work has been done in the field. Various theories have been advanced concerning the origin and growth of spatial perception. Child psychology serves as a logical basis for the beginning of the study of this complex function. Little actual experimental work has been done in the field of child study in space perception. From those investigations which have been carried on the conclusions reached are that the young child early begins to form a conception of spatial relationships to the right and left, up and down, or backward and forward.

Bodily orientation or sense of position is a factor which develops gradually. It is influenced by many factors. The adult regards himself as center of his own space and his regard of external objects is always in relation to his own individual space. Even in the very young child there is a consciousness for sense of position. However, the child regards external objects as a center of space. Delayed Reaction experiments have shown that rats, dogs, and some raccoons use bodily orientation as a cue to the reaction. Some raccoons and all children use some other factor which Hunter has named intra-organic (non-orientation) as a cue for the response.

PROBLEM

The purpose of this study was to determine the effect of bodily orientation upon memory for spatial placements of wooden rings on an easel designed for this experiment (Diagram I) and to note any factors which seem to influence ability to make successful placements. The effects of orientation was measured by changing the position of the easel in relation to the child.

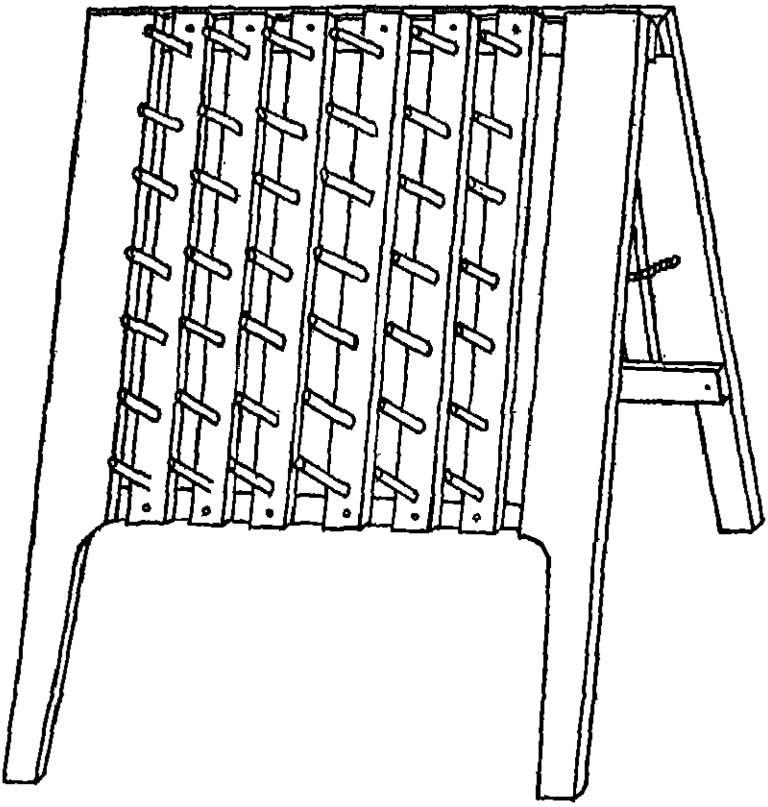


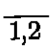
Diagram I

METHOD

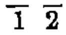
Positions of easels

After a preliminary experiment with 33 children, 9 positions of the easel were selected to be used in the study. In two of the positions only one easel was used; in all the others two easels were used, one for the child and one for the experimenter. The 9 positions arranged in the order of their seeming difficulty follow. In figures accompanying list of positions: 1 indicates position of child as examiner places ring; 2 indicates position of child as he places his ring.

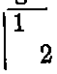
1. One easel



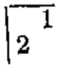
2. Two easels parallel to each other



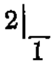
3. Two easels at right angles requiring one quarter turn to the right



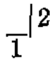
4. Two easels at right angles requiring one quarter turn to left



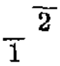
5. Two easels at right angles requiring three-quarter turn to left



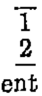
6. Two easels at right angles requiring three-quarter turn to right



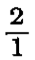
7. Two easels one behind and a little to the right of other



8. Two *easels facing each other*



9. One easel requiring movement to the opposite side of the easel



The easel upon which the experimenter placed her ring was kept in a constant position throughout the study, while the easel upon which the child placed his ring was changed to form the various positions. The two exceptions are positions 1 and 9 in which the same easel was used by both the experimenter and the subject.

Placement of rings on easels

Diagram II gives the twenty placements used. They were as follows in order of arrangement on the chart:

o 1	o	o	o 9	o	o 2
o 11	o 15	o	o 17	o	o 13
o	o	o 19	o	o	o
o 7	o	o 5	o 6	o	o 8
o 12	o	o	o 20	o	o 14
o	o	o 18	o	o 16	o
o 3	o	o 10	o	o	o 4

DIAGRAM II

Four corner placements (1, 2, 3, and 4).
Two center placements (5 and 6).
Four middle placements (7, 8, 9, and 10).
- a. Middle of the right side.
- b. Middle of the left side.
- c. Right center of the top side.
- d. Left center of the bottom side.

Two *placements on the left side* (11 and 12).
- a. Two places up from the middle.
- b. One place down from the middle.

Two placements on the right side (13 and 14).
- a. Two places up from the middle.
- b. One place down from the middle.

Two placements diagonally from the corners (15 and 16).
  a. Upper left corner down.
  b. Lower right corner up.

Four placements off center (17, 18, 19, and 20).
  a. Two places up right.
  b. Two places down left.
  c. One place up left.
  d. One place down right.

Subjects

Thirty-two children attending the nursery school of the Institute of Child Welfare at the University of Minnesota served as subjects in this study. Not all children completed all nine positions because of extended absences due to illness or withdrawal from the nursery school. Table 1 gives the number of children who completed the series of positions, and table 2 the number completing each position.

TABLE 1

Number of positions completed

TOTAL NUMBER OF POSITIONS COMPLETED	TOTAL NUMBER OF CHILDREN
9	27
8	1
7	2
4	1
3	1
Total number......	32

The children ranged in age from two to five years and were divided into three age groups, 12 children from 2 years 3 months to 3 years 5 months composed the three year group; 12 children from 3 years 6 months to 4 years 4 months composed the four year group; 8 children 4 years 6 months to 4 years 11 months made up the five year group.

I.Q.'s for the entire group ranged from 82 to 168.

Sex

The group was divided into 18 girls and 14 boys. The experiment was planned to include an equal number of each sex, but because some children showed negativism they could not be used successfully.

Interval between trials

Children were tested on alternate days as consistently as attendance permitted until the nine positions were completed. All children finished the series within three weeks with the exception of three children who finished within four weeks.

TABLE 2

Number of children completing each position

POSITION	CHILDREN
I	30
II	31
III	32
IV	28
V	29
VI	30
VII	31
VIII	31
IX	30
Total positions.....	272

Time of day

Of the total of 272 trials 233 were given in the morning between 9:00 and 11:15; and 39 trials were given in the afternoon between 2:30 and 3:30.

Elimination of practice effect

(*a*) *Position.* In order to distribute the effect of practice equally upon all nine positions, each position was given first to three or four children. Positions I, II, VIII and IX were given to 3 children first, and the remaining positions, III, IV, V, VI and VII were given to 4 children first. After the first definite position for each child, the remaining positions were given in chance order.

(*b*) *Placement.* Since there was also a possibility that practice might influence the success of the correct placing of the ring on the easel, the twenty placements were not presented to the child in consecutive order. Twenty different arrangements of the twenty placements were made so that each of the twenty placements occurred in the first, second, third, fourth, fifth, ... twentieth place in the series of twenty arrangements. Because there were more than twenty children used in the study each of the first twelve arrangements were given to two children and the other eight arrangements to only one child. Thus the experimenter had a definite order of presenting the placements to each individual child.

It was thought that the younger children might not coöperate if the placements which were given first were too difficult for them. Since the four corner placements were expected to be least difficult the arrangements which began with these placements were assigned to these children.

Testing room

The study was carried on in whichever research room was available at the time. All rooms are equally familiar to the children; thus the fact that the same room was not used all the time had no significant influence upon the response of the children.

Interval between the experimenter's and child's placement

The time elapsing between the experimenter's placing of her ring on the easel and the child's placing of his ring was never less than five seconds.

PROCEDURE

Situation

The easels were always arranged in the proper position for the trial before the child was asked to come into the room. The child was invited to come and play a game with the experimenter. In most cases one of the nursery school teachers told the child that Miss E. had asked him to play with her.

Directions

When the child came into the room for the first time the examiner said to him, "This is my little house (pointing to experimenter's easel). Now I am going to put my ring right here in my house and I want you to put your ring just like mine in your house." If the child did not seem to understand after the first trial the directions were repeated.

After the first time the child was told, "Today this is your house in this place, and I want you to put your ring just as I do in my house." Since the child's attention was inclined to waver after each placement, the examiner said, "Look where I am going to put it this time."

Length of time

The time required for making twenty placements at each trial was approximately five minutes for each child.

Incentives

Since after a few trials the game itself was no longer an incentive, though the children did not object to playing it, three kinds of incentives were used in consecutive order. First, the experimenter drew a simple outline picture of a house on a piece of paper which the child was allowed to keep. In order to keep interest at its height and to avoid any effect of indifference, a drawing of a wooden ring on a similar piece of paper was next used. Before the children became tired of this, the experimenter gave them cut-out paper rings of a different color each day.

RESULTS

The delayed reaction experiments which have been carried on with animals and children have shown that some animals and all children use some factor other than bodily orientation as a cue to the reaction. No one has actually attempted to determine the effect of bodily orientation upon memory for position of objects. The ability to adapt to spatial relationships is present in some degree in young children, as may be judged from their early ability to adjust themselves to space. Whether this ability in young children is affected by change in bodily position, or whether it is a constant ability may be solved only by empirical methods of study. There may be age differences in the effect which a change in bodily position has upon memory; that is, older children because of their greater experience or because of their actual age may be more or less affected through the setting of habits of reaction than younger children.

Effect of Change in Position

By tabulating the number of correct placements for each of the nine bodily positions, the order of difficulty of these positions was determined.

TABLE 3

Relative difficulty of nine orientation positions

POSITION	TOTAL NUMBER CORRECT	MEAN	S.D.	ORDER OF DIFFICULTY
I	534	17.82	2.65	1
II	200	6.45	3.501	3
III	165	5.55	2.823	4
IV	135	4.96	2.501	5
V	154	5.43	3.162	6
VI	147	4.64	2.440	7
VII	211	6.86	3.333	2
VIII	92	3.71	1.412	8
IX	48	1.81	1.201	9

Position I, in which the child placed the ring upon the experimentor's easel after she had removed her ring, was found to have the largest number of correct placements. From this it may be judged to be the easiest position, since there were three times as many correct placements as in the position having the next highest number of correct placements. Positions II and VII which are the two parallel positions, were of approximately equal difficulty as judged by average number of correct placements. Positions III, IV, V and VI, the four right angle positions were also of approximately equal difficulty, as evident from the similarity of average number of correct placements. Position VIII, in which the child's easel faces the examiner's, was slightly more difficult than the positions involving only a partial turn to the right or left. Position IX, which required the child to place his ring on the reverse side of the examiner's easel, was the most difficult, the average number of correct placements being less than two. The standard deviations of all the positions show very nearly equal variability of the children in the nine orientation positions.

These data seem to indicate that the more change in bodily position the child makes, the more difficult it is for him to put his ring in the proper place. Thus it may be inferred that bodily orientation has a distinct influence upon memory for placement of rings upon the easels used in this experiment.

In order to determine whether or not the test was of equal difficulty for all children the reliability of the difficulty of the nine orientation positions was found to be +.88, which is significantly high. This was computed by correlating the total number of correct placements for the odd numbered children with those for the even numbered children on the nine orientation positions. There may be factors other than a change in bodily position involved in this ability to remember ring placements. In other words, the influence of bodily position may be in part dependent upon chronological age, mental age, I.Q or sex of the subjects.

Chronological age

The influence of chronological age upon the effect of a change in bodily position is shown in Table 4 in which the subjects are grouped according to three ages, 3 years, 4 years, and 5 years.

There is a general increase in the average number of total correct placements from age group to age group. There is not, however, an equal increase between the 3 and 4 year olds and the 4 and 5 year olds, indicating possibly that the ability to make proper placements develops early and rapidly and does not show a constant increase. This seems to follow the general curve for mental growth which is characterized by negative acceleration. With more cases a conclusion could be made regarding that part of the developmental curve which falls between the ages of 21 and 59 months.

There is no consistent nor equal gain on the nine individual positions among the three age groups. However, there are no losses in total number of correct placements between age group I and II, while there are losses rather than gains for three of the nine positions between age groups II and III. Also, the gains are greater on the average between groups I and II, indicating that the large differences found between the average gains in total number of correct placements between groups I and II and groups II and III are not a matter of one or two positions only, but seem to be distributed quite equally over the nine positions. This suggests that the function involved is unitary; the nine positions merely representing different levels of difficulty along a given curve.

TABLE 4

Distribution of correct placements according to chronological age

AGE GROUP	NUMBER OF CHILDREN	TOTAL NUMBER CORRECT	MEAN NUMBER CORRECT	RANGE TOTAL NUMBER CORRECT	INCREASE AVERAGE NUMBER CORRECT
I. 3 years (27–31 months)........	12	525	43.75	24–68	
II. 4 years (42–52 months).......	12	672	56.00	39–82	Group I to II, 12.25
III. 5 years (54–59 months)......	8	474	59.24	54–98	Group II to III, 3.24

TABLE 5

Distribution of correct placements according to position and chronological age

POSITION	I 3 YEARS		II 4 YEARS		III 5 YEARS		AVERAGE GAIN IN NUMBER CORRECT	
	Mean number correct	S.D.	Mean number correct	S.D.	Mean number correct	S.D.	Group I to II	Group II to III
I	15.66	2.01	17.16	2.08	17.37	2.08	+1.50	+.21
II	5.00	2.08	7.83	3.13	7.87	3.14	+2.83	+.04
III	3.00	3.12	5.33	2.09	6.87	2.28	+2.33	+1.54
IV	3.00	2.09	5.16	3.12	4.75	2.94	+2.16	−.41
V	3.01	2.07	4.66	1.84	6.38	2.19	+0.75	+1.72
VI	3.66	1.88	5.06	2.80	4.63	2.96	+2.00	−1.03
VII	5.08	3.16	6.50	2.43	7.38	3.04	+1.42	+.88
VIII	3.00	1.67	3.08	1.33	2.87	1.80	+0.08	−0.21
IX	1.41	1.20	1.50	1.42	1.75	1.06	+0.00	+0.25

The correlation between chronological age and the total number of correct placements for the nine orientation positions is .77 ± .05 as computed by the Spearman rank order method. There is, evidently, some relationship between the ability to make proper placements and the chronological age of the child; but there also seems to be an indication that there are other factors which influence this ability.

Mental age

The correlation between mental age and number of correct placements is .758 ± .05. This indicates approximately a relationship equal to that found between chronological age and number of correct placements.

Specific ability

Since chronological age, mental age, and I. Q. seem not to be wholly responsible for the ability to make correct placements, there is indication of specific ability to remember the relationship of the ring to the easel. By correlating the total number of correct placements on all positions for the even numbered placements with the total number of correct placements on all positions for the odd numbered placements, the reliability of the problem as a measure of the particular ability involved for the various children is found to be .96. This seems to indicate, as suggested above, that there is a special ability in the young children used in this study, since the discrepancy between the reliability of the test as a measure of the orientation ability of the children and the correlation with either chronological age or mental age is greater than would be expected by chance.

Sex

Whether there is a significant difference between boys and girls in this study is shown by the average number of correct placements for each sex.

	Boys	*Girls*
Mean number correct...	50.00	52.40
S.D....................	10.53	14.66

No significant sex difference is found, except that girls seem to be more variable than boys. This difference too is within the limits of chance.

TABLE 6

Classification of errors

POSITION	SYMMETRICAL ERRORS				ERRORS IN ROW		ERRORS IN COLUMN		RANDOM ERRORS	TOTAL ERRORS
	Right	Left	Up	Down	Up	Down	Right	Left		
I	9	5			8	9	78	15	6	116
II	62	77			28	27	98	105	110	428
III	72	70			25	24	126	130	120	434
IV	99	73			20	23	145	124	110	422
V	86	57			28	39	152	94	116	429
VI	59	81			28	22	89	144	166	440
VII	47	85			20	42	69	132	126	389
VIII	113	114			24	16	172	131	142	485
IX	113	110			15	20	194	168	154	551
Total...	666	681			199	222	1,023	1,103	1,059	3,703
Mean...	74.0	75.6			22.1	24.6	113.5	122.5	115.4	411

Classification of Errors

Errors were classified into six groups as follows:

1. Symmetrical Errors—(i.e. reversal of placement, right and left—up and down).
2. Errors in Row—Number of places *up* (column correct).
3. Errors in Row—Number of places *down* (column correct).

4. Errors in Column—Number of places to *right* (row correct).

5. Errors in Column—Number of places to *left* (row correct).

6. Random Errors—Error in both row and column and non symmetrical.

Little difference is observed between the tendency to reverse a right position and the tendency to reverse a left position as is evident by the slight difference in averages, 74.0 and 75.6. It is interesting to note that there were no symmetrical errors up or down, which indicates that the young child distinguishes between up and down more successfully than between right and left. This is also indicated by the difference when the average number of errors in row are compared with the average number of errors in column. An average of 46.8 errors were made up and down, while an average of 236.00 errors to the right or left were made. The average number of errors up almost equals the average number of errors down; the difference is probably due to chance. The difference in the average number of errors to the right or left is also probably due to chance, since the actual difference is only 9 points for 1000 errors, while the actual difference between errors up and down is 2.5 points for two hundred errors. Obviously the relation is practically the same in the two cases.

The reliability of the difficulty of the twenty placements on the easel (sum of all the nine orientation positions) as determined by correlating the number of correct placements for odd numbered children with the number of correct placements for even numbered children, is .936, which indicates that the placements show a reliable difference in difficulty for all the children in this study.

Difficulty of placements

Table 7 presents the number of times each of the twenty placements was made correctly. The twenty placements were divided into four separate categories: 1. The four corner placements (Placements 1, 2, 3, and 4); 2. The six marginal side placements other than the corners (Placements 7, 8, 11, 12, 13 and 14); 3. The two marginal top-bottom placements other than the corners (Placements 9 and 10); 4. The eight inside placements (Placements 5, 6, 15, 16, 17, 18, 19 and 20). Table 8 shows the percentage of correct placements and the standard error for each of the four

TABLE 7

Difficulty of twenty placements

PLACEMENT NUMBER	TOTAL NUMBER CORRECT	PERCENTAGE CORRECT	ORDER OF DIFFICULTY
1	118	43.30	19.5
2	118	43.3	19.5
3	110	40.4	17.
4	111	40.7	18
5	64	23.5	6.5
6	54	19.8	3
7	58	21.3	4
8	66	24.2	9
9	94	34.5	13.5
10	101	37.1	16
11	95	34.9	15
12	78	28.6	11.5
13	94	34.5	13.5
14	63	23.1	5
15	64	23.5	6.5
16	53	19.4	2
17	78	28.6	11.5
18	70	25.6	9
19	51	18.7	1
20	65	23.7	8

categories. This table indicates that the four corner placements had the highest percentage of correct placements with a small standard error. The marginal placements were next in difficulty, the top-bottom placements, having a larger standard error, indicate a greater variability. The inside placements were decidedly the most difficult the standard error showing a small variability for the children of the study.

TABLE 8

Percentage of correct placements in four categories

CATEGORIES OF POSITIONS	PERCENTAGE CORRECT	σp
I. Four corner.......	.420	.016
II. Marginal side (Other than corner)..........	.378	.013
III. Marginal top-bottom (other than corners).........	.358	.021
IV. Central...........	.210	.009

TABLE 9

Relation between the actual differences and the standard error of the difference in percentages of correct placements in four categories

CATEGORIES	1	2	3
2	2.1		
3	2.37	.76	
4	17.5	9.30	5.29

In order to determine if the difference between the percentages of correct placements was significant the standard error of the difference of the percentage of correct placements of the four categories was calculated and the actual difference in percentage was divided by the standard error of the difference. Table 9 indicates that there is a significant difference between each of the four categories of placements; they were not, therefore, of equal difficulty. The difference between the corner placements and the marginal side placements is twice (2.1) its standard error which indicates a significant difference in difficulty of these two types of placements. Marginal side placements and marginal top-bottom placements were of approximately equal difficulty, the difference of percentage of correct placements being only .76 that of the standard error of the difference. The difference between the corner placements and the inside placements has a highly significant ratio (17.5). There is also a significant difference between marginal side and central placements and between marginal top-bottom and central placements as shown by the ratios 9.30 and 5.29 respectively. Thus it can be said that the four corner placements were the easiest; the marginal-side placements ranked next in difficulty, with the marginal top-bottom placements showing almost equal difficulty, and the inside positions being the most difficult.

The data of this study may be interpreted in the light of some of the theoretical conclusions which have been advanced in regard to spatial relationships and change in bodily position. According to Stern (11) the child of one year can distinguish "far" and "near," "above" and "below," "right" and "left." The data of this study show that all the children used in the study had some grasp of spatial relationships since no child failed any single placement in all nine positions. Even in the youngest child some ability to grasp spatial relationships was already present. Stern (11) also points out that the child's mastery of space is not perfect in these early years and that there are many misconceptions of spatial relations. Data of the study confirm this by the various types of errors which were made. That this spatial conception develops with age is indicated by the increase in the total number of correct placements for each of the three age groups of the study.

Koffka (7) also asserts that the ability to adjust to spatial relationships is early evident in young children. He believes that adjustment, however, is a process of maturation. Since there is an increase in the total number of correct placements with increase in age it suggests that this may be a process of maturation.

Stern (11) presents the idea that the tactual-motor action may be an aid in the child's conception of spatial relations. In this study the child not only was able to see the easel with the ring in the proper place but also he was required to duplicate the configuration (to use Koffka's term) which he saw. This motor association with the visual perception may have helped to increase his ability to make a correct placement of the ring.

Results of the study are in close agreement to those found by Meyer in the experiment previously mentioned. In this study there was also a tendency toward error; the errors which were recorded were especially those of reversal of right and left side (symmetrical errors) and error in which the ring was placed in a position neighboring to the original.

Stern (11) in his discussion dealing with the child's sense of position says that in human beings the individuals own body is his center of space; thus one's conception of right, left, up, and down are in relation to one's own body. Trowbridge, however, states that young children do not use their own body as a center of space but that they use some external object as a point of reference. The data of this study seem to be in agreement with Trowbridge. In Positions I, VII and II where the child was not required to make any bodily turn there was a greater number of correct placements which may mean that the point of reference was consistant for these positions. In Positions VIII and IX where the child was required to make a complete turn of body in order to place the ring correctly we find a tendency for a much greater number of symmetrical errors. This may indicate that some external factor was used as an orientation cue for the correct placing of the ring. Thus when there was a complete turn of the body the reversal of right and left was the most frequent error. Here then is the tendency to put the ring on the same side of the easel as that on which the experimenter had her ring; thus the child was not able to make the distinction between right and left. The corner and marginal placements were decidedly easier than the inside placements. This may indicate that the children of this study used some external object as a point of reference rather than their own bodies.

Results of the study confirm the

statements which have been made in regard to the fact that young children distinguish between up and down earlier than between right and left. The classification of errors shows there are more errors made to the right and left than up and down. This fact may also be indicative of an external point as center of space which in this case might possibly be the floor.

That there is an ability for young children to adjust themselves to spatial relations is evident from the data of the study. That this ability is affected by change in bodily position is shown in data indicating that more correct placements were made in those positions where the child was not required to make any bodily turn. Those positions necessitating a turn of 360 degrees were the most difficult, while those requiring only a partial turning were between the extremes in difficulty. It would seem from this that the amount of turning affected the correct placement of the rings. Data seem to indicate by the number of errors made to the right and left that the child uses some point of reference external to his own body as a center of space. The fact that there are more errors made to the right and left in comparison to errors made up and down confirms the frequently made statements that the young child distinguishes between up and down earlier than between right and left.

SUMMARY

The purpose of this study was to determine the effect of bodily orientation upon memory for spatial placements of wooden rings on an easel designed for this experiment, and to note any factors which seem to influence ability to make successful placements.

Positions

The two most difficult positions were those which necessitated a complete turn of 360 degrees on the child's part; they were the situation in which the reverse side of the easel was used, and that in which the two easels faced each other. The easiest positions were those which required no turning of the child's body in order for correct placements to be made. The positions between the extremes in difficulty were those requiring the child to make a turn of 90 or 180 degrees. The reliability of the difficulty of the nine positions for the 32 subjects was .88.

There was a general increase with age in the total number of correct placements for the nine positions, although the increase was not equal or consistent between the age groups used in this study. The correlation between chronological age and the total number of correct placements is .77 ± .05.

Since a reliability coefficient of .96 was found for the problem as a measure of the particular ability involved there may be an indication that bodily orientation is a special ability in the children used in this study. The correlation between mental age and the total number of correct placements is .758 ± .05.

There were no significant sex differences found in the study.

Placements

Little difference in symmetrical errors to the right or to the left were evident; no symmetrical errors up and down were made. There was a greater tendency to make errors to the right and left than to make errors up and down. A reliability of .936 was found for the difficulty of the twenty placements on the easel in the nine positions. The four corner placements were found to be the easiest and the marginal placements were next in difficulty, although the difference between the two were within the limits of chance. The inside placements were found to be decidedly the most difficult for the children of this study.

Conclusion

The data in this study indicates that change in bodily position does affect the memory for position of objects. This was shown by the decrease in the number of correct placements made in those positions which required either a partial or a complete turn of the body. The evidence is that the greater the amount of bodily change the fewer the number of correct placements.

REFERENCES

(1) Baldwin, J. M.: Dictionary of philosophy and psychology, New York: MacMillan Company, 1902, Two Volumes.

(2) Baldwin, Bird T. and Stecher, Lorle I.: Psychology of preschool child. New York: Appleton & Company, 1925.

(3) Court, Sophie R. A.: Numbers, time and space in first five years of child's life. Pedagogical Seminary, 1920, 27, 71-85.

(4) Hunter, Walter S.: General psychology. Chicago: University of Chicago Press, 1923.

(5) Hunter, Walter S.: Delayed reactions in animals and children. Behavior Monographs, 1913, 2, 1-86.

(6) Hunter, Walter S.: Delayed reactions in a child. Psychological Review, 1917, 24, 74-87.

(7) Koffka, Kurt: Growth of the mind. London: Harcourt Brace & Co., 1925.

(8) Lashley, K. S. and McCarthy, Dorothea A.: Survival of maze habit after cerebral injuries. Journal of Comparative Psychology, 1926, 6, 423-435.

(9) Peterson, Joseph: Illusions of direction of orientation. Journal of Philosophy, Psychology and Scientific Methods, 1916, 13, 225-236.

(10) Pillysbury, W. B.: Fundamentals of psychology. Revised Edition. New York: MacMillan Company, 1922.

(11) Stern, William: Psychology of early childhood. New York: Henry Holt and Company, 1924.

(12) Swindle, P. F.: Time, perception and rhythm. Psychological Bulletin, 1920, 27, 244-250.

(13) Titchener, E. B.: A text-book of psychology. New York: MacMillan Company, 1921.

(14) Trowbridge, C. C.: Importance of lateral vision in its relation to orientation. Science, 1927, 44, 471-474.

(15) Watson, John B.: An introduction to comparative psychology. New York: Henry Holt & Company, 1914.

(16) Williams, Mabel G.: Visual space. Psychological Bulletin, 1920, 17, 241-243.

(17) Williams, Mabel C.: Visual space. Psychological Bulletin, 1917, 14, 322-323.

(18) Woodworth, Robert S.: A study of mental life. New York: Henry Holt & Company, 1921.

(19) Wundt, William: Outlines of Psychology. Leipzig. Wilhelm Engelman, 1902.

A Slide Rule for Calculating Ages[1]

JUNE F. CONSTANTINE

RARELY is a research problem completed in the field of child development and education without harking back to the arithmetic processes for changing years to months and months to days in which we were drilled so assiduously in the sixth grade. In fact, practically every field of research today takes into account the span of time as an important factor, whether it be for humans, animals, or inanimate objects.

The two main age problems which face the worker in child development are: (1) How old were these children on a certain date? (2) How old was this child on various dates? The slide rule to be discussed was constructed to solve either of these two problems with a minimum amount of time and error. Further research has shown that it can handle adequately many more.

Since the research worker generally uses a thirty day month, it is possible to use equal divisions on all the scales. In order to simplify the matter further, a table of yearly increments was devised. Table 1 is a section of this table. At first glance there is a consistent error of one year in this table. This was done purposely as the problem was then simplified into one of always adding the increment as shown on the instrument to the yearly increment. That is, two persons born on June 3, 1909, and December 4, 1909, respectively, would have on September 22, 1930, an age of twenty plus the amount on the scale. The increment added for the former would be 1 year, 3 months, 19 days; for the latter 9 months, 18 days. If actual year ages were taken the latter would have been 21 years (thirty minus nine) less 2 months, 12 days. However, it is generally accepted that consistent repetition of an act produces a mental set which is more conducive to accuracy and speed than the shifting back and forth between two activities.

TABLE 1

Yearly increments

YEAR OF BIRTH	YEAR OF MEASUREMENT					
	1929	1930	1931	1932	1933	1934
	Increments					
1922	6	7	8	9	10	11
1923	5	6	7	8	9	10
1924	4	5	6	7	8	9
1925	3	4	5	6	7	8
1926	2	3	4	5	6	7
1927	1	2	3	4	5	6
1928	0	1	2	3	4	5
1929		0	1	2	3	4
1930			0	1	2	3

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[1] From the Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

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Hence, it is better to add consistently since addition is the fundamental arithmetic process.

The calculator is made on the order of a very simple slide rule with four scales, two of which are on a center slide. In attacking a specific problem only two of the four scales are used at a time. Thus if one measures forty children on November 15, 1930, and wishes to record their ages, place an end point of the sliding scale above 11–15 on Scale A (fig. 1). This is all the setting the instrument requires.

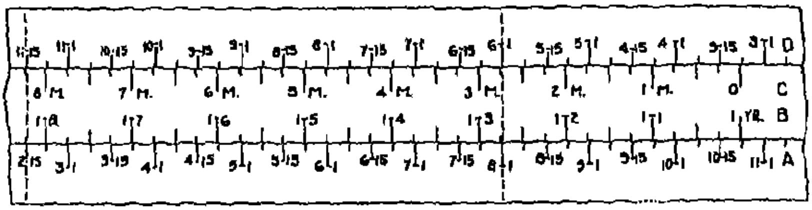

FIG. 1

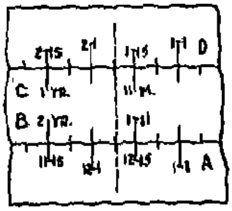

FIG. 2

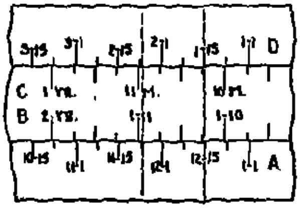

FIG. 4

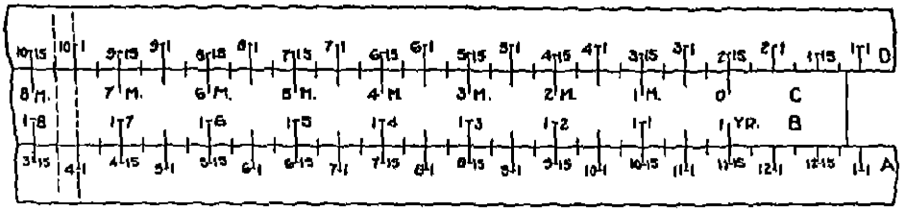

FIG. 3

A child born on April 1, 1922, is 7 (1930 minus 1922 minus 1) years plus 1 year, 7 months, 15 days of age. To obtain the increment 1–7–15 look on Scale B above 4–1 (April 1) on Scale A. The point is midway between 1–7 and 1–8 or 1–7–15. A child born on March 23, 1906, is 23 (1930 minus 1906 minus 1) years plus 1 year, 7 months, 22 days. And so on for all children born before November 15. For those born after November 15, set the other end point of the slide above 11–15 (fig. 2) and proceed in a like manner using the increment from Scale C. A birth date of December 8, 1915, gives an age of 14 years plus 11 months, 7 days. If ages are desired only to the nearest month, one can tell at a glance on which side of the half mark the age will fall since 6 months, 15 days is 6 months, while 6 months, 16 days is 7 months.

Our second important problem is to ascertain the age of a given child on any day or days, or to discover when a child will have a required age. This might well come up in a study involving repeated measurements.

Take a child who was born on March 8, 1916. Set an end point of the sliding scale below 3–8 on Scale D (fig. 3). The child's age on June 1, 1920, as read from Scale B is 3 (1920 minus 1916 minus 1) plus 1–3 equals 4 years, 3 months; on November 15, 1926, 9 (1926 minus 1916 minus 1) plus 1 year, 8 months equals 13 years, 8 months respectively. The child's age on January 15, 1918, and February 6, 1930, will be found by setting the other end point under 3–8 (fig. 4) and taking the increment from Scale C. The ages would be 1 plus 10 months or 1 year, 10 months, and 13 plus 11 months equals 13 years, 11 months respectively.

One might well ask if this is an improvement over other methods of calculating ages. To date, the writer knows of only two other ways,[2] the arithmetic process and the Englehardt-White Age Calculator. The Englehardt-White Age Calculator is built to give ages to the nearest first of any month or as of September 1 or March 1. There are two sectors on a revolving scale, one for finding age as of September or March first and the correction to the month sector. Numerous tests have been conducted to discover their relative merits, from the standpoint of speed and accuracy. The subjects consisted of two staff members of professorial rank, two research assistants, one each from child development and psychology of music, two clerical assistants, and the author. With the exception of D, all the subjects were timed on the use of the slide rule ten or fifteen minutes after they had seen it for the first time.

TABLE 2

Comparison of the slide rule arithmetic and Englehardt-White calculator methods

SUBJECT	SLIDE RULE		ARITHMETIC		ENGLEHARDT-WHITE AGE CALCULATOR	
	Time	Errors	Time	Errors	Time	Errors
	minutes		*minutes*		*minutes*	
A	7	0	9	2		
B	12	0	12	2	15	6
C	11	1	20	1		
D	6	0	7	1	13	10
E	9	4	14	0		
F	25	4	13	11		
G	18	2	13	2		

Distribution of time required and errors made by each of seven subjects in computing forty ages by the methods listed is given in table 2.

The test consisted of a list of forty birth dates for which the age was to be computed for a given date, June 15, 1930. The birth dates were taken at random from record cards. June 15 was chosen since there would then be even chances of having to borrow months or days in using arithmetic.

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[2] Since this study was conducted the writer has found another age calculator, the Young Age Calculator, which calculates ages to the full month rather than to the nearest month.

The two tests of the Englehardt-White Age Calculator were made by persons who had used it a great deal and were familiar with its limitations. Even with the utmost care, however, it seems almost impossible to compute the ages accurately to a month.

A glance at the table will show that in over one-half of the cases the time was cut and the errors reduced when using the slide rule. The consensus of opinion of the last three subjects was that a little more practice in reading the scale would be a great help since they had never before come in contact with any type of slide rule. As it was, half of the errors in using the slide rule were made in obtaining the yearly increment incorrectly.

Even if there had not been a noticeable increase in speed and accuracy between using the slide rule and arithmetic in this short experiment, there would still be the question of efficiency over a protracted period of calculating. There is reason to assume that the fatigue point would be reached much later when using this device, just as in using other mechanical computing devices.

Some Conditions in the Dentition of Preschool Children

S. IDELL PYLE AND CHARLES L. DRAIN

DURING the last four years dental examinations have been made annually of those children who have attended the preschool laboratories of the Iowa Child Welfare Research Station. The examination included a notation of the number of teeth erupted and shed, inspection for cavities, fissures and abnormalities of the teeth, and an estimation of the general condition of the mouth. These data have been summarized to demonstrate the condition of the first dentition of the preschool child, and present another phase of the development to supplement that phase as previously described by their physical measurements (1).

One hundred and eighty-four boys and 189 girls were examined. The children came from homes where information and resources for proper health and dental instruction were easily available. They ranged in age from 18 months to 77 months inclusive. They were divided into age groups, the two-year age group consisting of those children between one year, six months, and zero days and two years, five months, and twenty-nine days. By this division the greater number of the children were in the four- and five-year-old groups.

The age distribution of children having examinations was as follows:

AGE	BOYS	GIRLS
years		
2	22	19
3	34	49
4	49	50
5	60	57
6	19	14
Total......	184	189

ANALYSIS OF DATA

Eruption and shedding of teeth

At the outset examinations were made chiefly to advise the parents about the condition of the teeth already erupted. Hence, while the number of teeth erupted was recorded, no emphasis was placed upon the order of eruption. As the work progressed

TABLE 1

Mean number of teeth erupted at two and three years of age

AGE	BOYS		GIRLS	
	Mean	P.E.$_M$	Mean	P.E.$_M$
years				
2	17.41	1.08	16.16	0.38
3	19.59	0.89	19.61	0.94

this item was included, but not enough information has been collected to date to include it in this discussion.

All children in the four-, five-, and six-year groups had their first dentition. It is interesting to note that only 2 boys and 4 girls had shed any teeth by 6 years and 6 months of age. Seven boys and 7 girls had two or more of the first permanent molars erupted.

TABLE 2

Mean, standard deviation, and probable error of the mean of the number of cavities per child and the number of teeth affected, and the percentage of each age group having defective teeth

AGE	CAVITIES PER CHILD			NUMBER OF TEETH AFFECTED			DEFECTIVE TEETH
	Mean	S.D.	P.E.$_M$	Mean	S.D.	P.E.$_M$	
				Boys			
years							*per cent*
2	1.00	2.73	0.38	0.73	2.04	0.29	18.2
3	0.91	2.31	0.26	0.73	1.79	0.21	23.5
4	2.16	4.10	0.39	1.55	2.71	0.28	42.8
5	5.75	6.33	0.52	2.33	4.55	0.40	73.3
6	3.94	4.22	0.65	2.70	3.30	0.52	68.4
				Girls			
2	0.00	0.00	0.00	0.00	0.00	0.00	00.0
3	0.65	1.92	0.18	0.51	1.33	0.13	24.5
4	2.96	4.40	0.43	2.14	2.68	0.25	54.0
5	4.89	6.76	0.60	3.22	4.12	0.37	64.9
6	6.64	2.35	1.38	4.14	4.50	0.82	71.4

The earliest age at which their eruption was noted was at 61 months.

Table 1 shows the mean number of teeth present at two and three years of age.

Ratios were computed to determine whether a sex difference in time of eruption existed. This ratio was calculated by dividing the difference between the mean number of teeth erupted by the probable error of the difference. A ratio of 3.0 or more was considered significant. The ratio was 0.38 for the two-year-old children, and showed that there was not a significant sex difference between the boys and girls in the age at which their teeth were erupted. Of the boys, 22.7 per cent had 20 teeth erupted, but only one girl had the first full denture. The difference between the three-year-old boys and girls was not significant, doubtless due in part to the fact that 82.2 per cent of the boys and 92.9 per cent of the girls had 20 teeth erupted. The youngest boy with a full complement was 27 months old and the youngest girl 29 months old. The oldest boy who had less than twenty teeth was 35 months old and the oldest girl 37 months old. The average age for the 23 boys having less than twenty teeth erupted was 27.78 ± 0.63 with a standard deviation of 4.47 months and for the 27 girls 27.56 ± 0.69 with a standard deviation of 5.29 months. This difference in the age was not significant.

Supernumerary teeth

Supernumerary teeth were rarely found. Two boys each had an extra lateral incisor. No other anomalies in number of teeth were noted for the entire group.

Prevalence of cavities

In calculating the number of cavities the total number was considered as well as the number of teeth affected. This seemed pertinent, since often a tooth would have a break in the enamel in various parts of it without having a continuous defect of the entire surface. If only the total number of cavities was noted a somewhat spurious idea of defects in teeth could be deduced. Table 2 is a summary of these data.

The two- and three-year-old boys had a greater average number of teeth affected than did the girls, but in the three older age groups the reverse was true. At no age was the sex difference significant. The standard deviations were large. The percentage of children in each group with no cavities indicated that the wide range was partly due to the fact that 50 per cent of the two- and three-year-old children had no cavities and 40 per cent of the four- and five-year-old children had none.

Sex differences in numbers of cavities

The four- and five-year-old groups of each sex were then considered together to see whether any consistent sex difference in number of cavities existed. One hundred and nine boys and 107 girls were compared. The boys had an average of 4.14 ± 0.39 cavities with a standard deviation of 5.95 cavities and the girls 4.04 ± 0.37 cavities with a standard deviation of 5.65 cavities. These figures are a rather interesting comment on the very bad dental condition found for some of these children since 41.3 per cent of the boys had no cavities and 40.2 per cent of the girls had none. The ratio of the difference between the means to the probable error of the difference again showed no significant sex difference.

TABLE 3

Percentage of total cavities located in each surface in each age group

AGE	SURFACE				
	Occlusal	Distal	Mesial	Lingual	Buccal
	Boys				
years	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
2	22.7	18.2	50.0	0.0	9.1
3	45.2	9.6	29.0	6.5	9.7
4	55.7	14.4	18.3	4.8	6.7
5	44.3	20.1	28.4	1.9	5.2
6	54.7	26.7	16.0	0.0	2.6
	Girls				
2	00.0	00.0	00.0	0.0	0.0
3	72.2	5.6	13.9	5.5	2.8
4	64.0	13.6	12.8	5.4	3.4
5	41.6	25.4	29.0	1.8	2.2
6	37.6	28.0	33.3	0.0	1.1

Location of cavities

The location of cavities was next considered. The total number of cavities in each of the five surfaces of the tooth were averaged to see which surface was the most frequent site of decay. For this summary the incisive surface of the incisors and cuspids were called occlusal, and their labial surfaces were designated as buccal. The results are given in table 3.

TABLE 4

Mean per cent of cavities according to teeth in each age group

AGE	RIGHT TEETH					LEFT TEETH				
	Second molar	First molar	Cuspid	Lateral incisor	Central incisor	Central incisor	Lateral incisor	Cuspid	First molar	Second molar
	Mean per cent									
	Boys—Upper teeth									
years										
2	00.0	0.0	0.0	9.1	18.2	18.2	9.1	0.0	0.0	00.0
3	22.5	6.5	0.0	6.5	16.1	9.6	3.2	0.0	3.2	16.1
4	17.3	0.0	1.0	3.8	7.7	3.8	5.8	1.0	1.0	10.0
5	10.1	5.8	1.4	3.5	6.4	6.1	2.6	1.2	5.2	8.4
6	10.7	5.3	2.7	4.0	5.3	0.7	1.7	0.0	8.0	6.7
	Boys—lower teeth									
2	4.5	4.5	0.0	4.5	9.1	4.5	4.5	0.0	4.5	9.1
3	6.5	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	6.5
4	14.4	6.7	1.9	1.0	1.0	1.0	1.0	1.0	9.6	10.6
5	11.9	7.5	0.8	0.6	1.2	1.2	0.3	0.8	11.6	13.0
6	2.7	9.3	1.7	0.0	0.0	0.0	0.0	1.7	24.0	10.7
	Girls—upper teeth									
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	15.6	10.7	5.6	0.0	2.8	8.3	11.1	0.0	0.0	16.7
4	16.8	5.4	2.0	2.7	5.4	4.7	0.7	0.0	6.1	14.8
5	10.7	5.0	0.7	4.3	6.8	6.1	3.6	1.1	8.6	11.1
6	0.7	11.8	3.2	6.5	7.6	7.6	3.2	1.1	10.8	8.0
	Girls—lower teeth									
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	8.3	11.1	2.8	0.0	0.0	0.0	0.0	0.0	0.0	16.7
4	13.5	7.4	0.7	0.7	0.0	0.0	0.7	0.7	5.4	12.1
5	10.4	8.9	1.1	0.4	0.0	0.4	0.7	1.1	9.6	9.3
6	6.5	8.6	2.0	0.0	0.0	0.0	0.0	1.1	7.6	8.6

Cavities were found most frequently in the occlusal surface, and next most frequently in the mesial and distal surfaces. The proportion of occlusal cavities to distal and mesial was slightly greater for girls than for boys. The boys had more cavities in the buccal surface than did the girls.

The manner in which cavities were distributed in the teeth was investigated also. The molars were most often affected. In the small group of two-year-old boys the upper central incisors were decayed most frequently, but in no other group were these teeth, which usually erupt first, the most frequent sites for caries. Table 4 shows their distribution.

Low attached frenum

A low attached frenum was not very prevalent. Cases were found scattered throughout all the age groups. This condition was present for 13.0 per cent of the boys and 16.4 per cent of the girls.

Fissures

Of the boys, 6.5 per cent and of the girls, 7.9 per cent had fissured teeth. With one exception, the defect always occurred in the molars.

Fillings

It was interesting to note the reaction on the part of the parents as to defects in the dentition. Usually repair of defects was optional with them. They were always notified immediately regarding the condition of the teeth, and urged to visit their own dentist. During the third year of the survey, an investigation was carried out to determine the amount of actual repair and prophylactic work done. Seventy-seven out of a group of 80 children had received adequate dental attention. But when the results from all four years are estimated together, less than one-fifth of the cavities were found filled when the dental examination was made. Of the cavities found 11.1 per cent of those of the girls were filled and 10.1 per cent of those of the boys. Fillings were noted in the molars a little more frequently than in the other teeth.

These results indicate to us two things, namely, the striking need for a program of dental health education whereby spontaneous parental interest in the condition of the child's deciduous teeth can be stimulated, and second a need for intensive investigation on the part of research workers into the specific effects of lack of repair and care of this denture on the health of the child.

Condition of the mouth of relation to cavities

The general condition of the mouth was rated as follows: clean, fairly clean, unclean, very unclean. Considering all the boys and girls together 22.4 per cent were rated as having clean mouths, 55.1 per cent as fairly clean, 21.1 per cent as unclean, and 1.3 per cent as very unclean. These ratings were made according to the presence of removable discoloration on the teeth, the need for general prophylaxis and the evidence of the kind of daily care and attention given to the teeth and mouth.

Finally, those children who had more than the average number of cavities were selected and their general mouth condition studied. This grouping was made by adding to the mean number of cavities found for each age two probable errors of the mean, in order to give a broader interpretation than that given by the mean value alone. There were 39 girls and 46 boys of whom 7.1 per cent had clean, 47.1 per cent fairly clean, 41.1 per cent unclean, and 4.7 per cent very unclea mouths.

It is true that this estimation of mouth condition was based upon one examination. The evidence points to the need for better care of the mouth in young children, even if this analogy does not present a clearly defined relationship between occurrence of cavities and general condition of the mouth.

SUMMARY

Dental examinations were made of 184 boys and 189 girls ranging in age from eighteen months to seventy-seven months who were in attendance at the preschool laboratories of the Iowa Child Welfare Research Station. The investigation revealed:

1. That 40 per cent of the two- and three-year-old children were 27-months-old before the first dentition was completed.

2. That there was no sex difference in the number of cavities found.

3. That cavities occurred most frequently in the occlusal surface of the tooth, and next most frequently in the mesial.

4. That the molars had the greatest number of cavities and that the upper teeth were affected more frequently than the lower.

5. That the relationship between general condition of the mouth and occurrence of cavities could not be clearly demonstrated.

6. That the need for dental health education particularly at this age is clearly indicated.

REFERENCE

(1) IOWA CHILD WELFARE RESEARCH STATION: Physical traits of young children. Amer. J. Dis. Child., 1929, 38, 541–546.

A Cold Light for Photographing Infant Reactions with the High-Speed Motion Picture Camera[1]

ORVIS C. IRWIN

IN PROJECTING a series of photographic studies of the reactions of newborn infants with a high speed motion picture camera, some difficulties in securing adequate illumination were encountered. A special technique had to be devised for this work, since the requirements for illumination are somewhat different from those ordinarily used. These requirements are: (1) sufficient intensity at high speeds of the camera to photograph very rapid infant movements, (2) absence of heat to avoid burning the skin of the infant, (3) elimination of rays injurious to the infants' retinas, (4) constancy of illumination for extended periods, (5) adaptability to the experimental situation (in this case to an experimental cabinet).

After a series of trials it was found that incandescent lights using high wattage and a special surgical lamp failed to meet the requirements. The incandescent lights gave off too much heat at intensities needed for adequate illumination at the high camera speeds. The surgical lamp although it was equipped with a water cell to absorb heat, was too awkard to manipulate in the cabinet in which the infants are photographed.

A neon light was devised to meet the requirements of photographing the movements of newborn infants without injury. It consists of two neon grids[2] made of lead glass tubing, one of which furnishes the greater amount of illumination, and a second smaller grid which gives enough light to eliminate shadows cast by the first. The main grid is constructed of 16 feet of 10 mm. tubing bent into seven parallel sections and is mounted on a mirror 12 inches by 28 inches. It is suspended at a 45 degree angle by adjustable levers 15 inches above and to the right of the infant. The second grid is made of 12 feet of 8 mm. tubing bent into five parallel sections. It is mounted on a mirror 9 inches by 28 inches and is suspended on the left side of the infant. Both grids are equipped with standard neon sign electrodes which are connected at opposite corners to the grid in order to avoid sparking. The tubes are filled with a gas mixture commercially known as Airco B-10 to which mercury has been added. The gas pressure within the tubes is 10 mm. of mercury. The tubing is made of lead glass, a Corning Glass Company product known as Gl. The large grid is operated by a 15,000 volt neon sign transformer having a secondary current of 30 milliamperes. The smaller grid is operated by an 8,750 volt transformer giving a secondary current of 23 milliamperes. The accompanying photograph shows the illuminated grid.

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[1] From the Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

[2] The feasibility of using the neon grid for work with infants was suggested by the successful photographic use of a neon time light by Dr. Joseph H. Tiffin. Department of Psychology, State University of Iowa, Iowa City, Iowa.

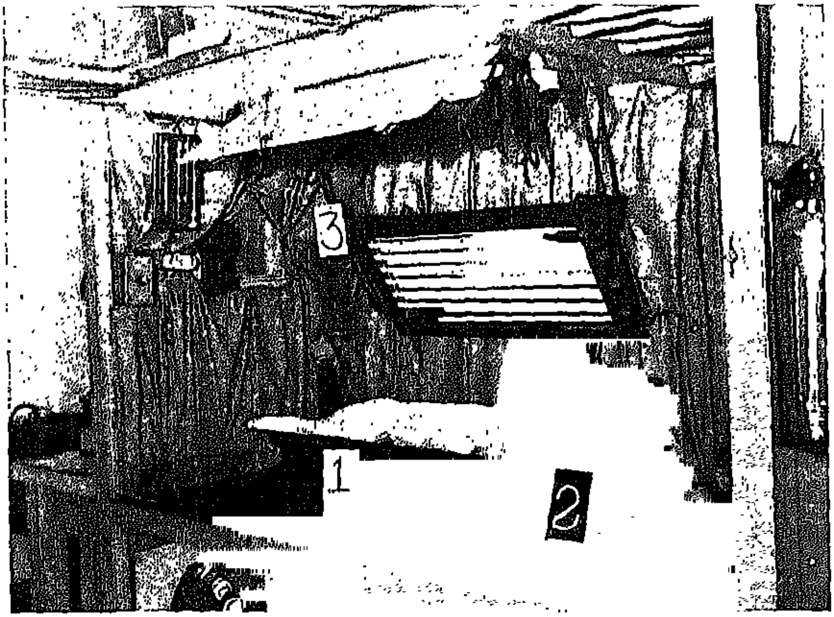

FIG. 1. SHOWING NEON LIGHT GRID (NO. 3) INSTALLED IN EXPERIMENTAL CABINET

The illumination provided by this light is sufficient to take motion pictures at the rate of 32, 52, or 72 pictures per second of infant reactions too rapid in their motion to be followed by the eye. The appended samples of film taken at these rates show the degree of clearness of each. The requirement of a heatless light, so important in work with newborns, is successfully met by the B-10 mercury light. The glass is barely warm to the touch and at five inches no heat can be felt. The Airco B-10 mixture when used without the addition of mercury shows a spectrum in which the predominating lines are those of argon. The emission under these circumstances will be comparatively little in the ultra-violet region. If the mixture is used with mercury, the mercury lines will predominate in the spectrum, showing some radiation in the ultra-violet region. However, the use of a high grade of lead glass in the tubing insures the elimination of injurious ultra-violet radiation. The constancy of illumination, it was found, depends upon the length and size of the tubes, and upon the voltages impressed on the electrodes. With transformers of the voltages indicated, flicker is eliminated. The grids as designed can be installed and easily manipulated in a limited space such as is afforded by the experimental cabinet.

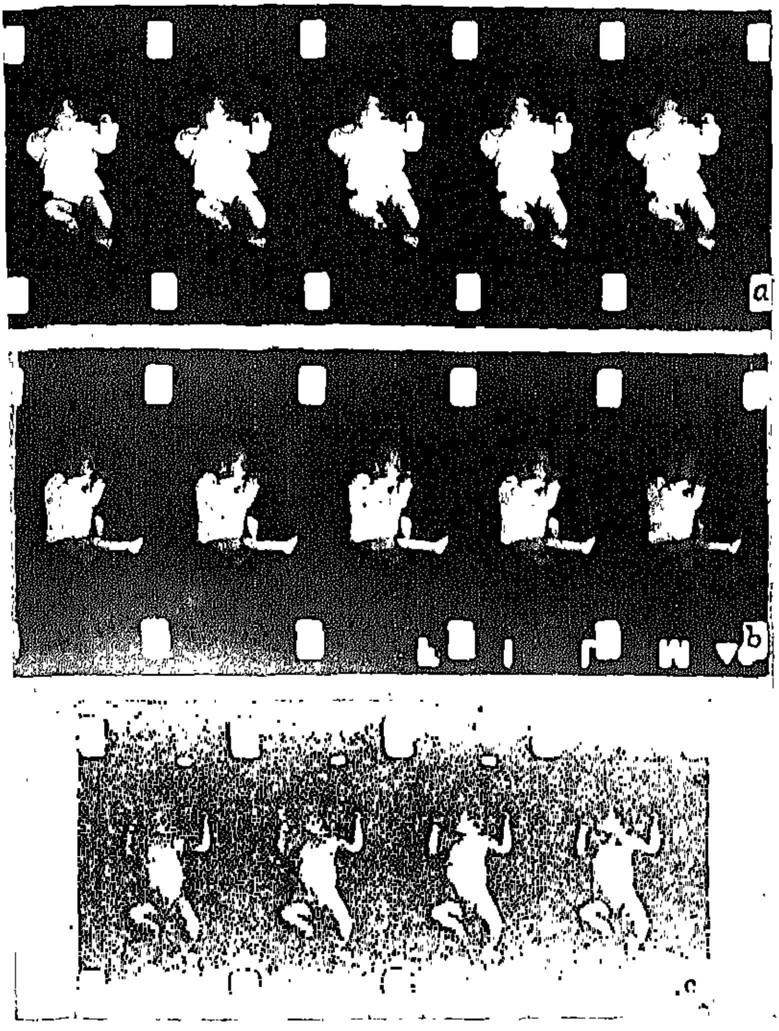

FIG. 2. ENLARGEMENTS OF FILM: (*a*) 32 PICTURES PER SECOND; (*b*) 52 PICTURES PER SECOND; (*c*) 72 PICTURES PER SECOND

Brief Reports

The Effects of Practice in Tracing the Porteus Diamond Maze*

THIS study is concerned with the effects of specific practice upon the ability of young children to trace the Porteus Diamond Maze. The subjects were 24 children ages 24 to 40 months in attendance at the Washington Child Research Center. They were first given an initial test on the maze consisting of 2 trials with each hand. The performance was scored by a method similar to that reported by Baldwin and Stecher (1). A diamond model of isinglass divided into 44 equal segments was superimposed upon the child's traced diamond. For every segment in which the child's line left the maze one point was deducted from the maximum score of 44. On the basis of the average of the two scores with the preferred hand (the hand with which the best score was made) two groups of children were formed, so that the mean score of each group was 23.0 and the standard deviation 15.1. The two groups were also made approximately equal in average age and age distributions.

The 12 children in the practice group repeated the test (a test consisting of 2 trials with the preferred hand only) 7 times. On account of absences not all tests could be given at exact intervals, but in general a weekly interval was maintained. Both groups were then given 2 end tests on the maze. The first end test was the same as the initial test—2 trials with each hand—while the second consisted of 2 trials with the preferred hand. This gave the practice group a total of 20 tracings with the preferred hand and 4 with the non-preferred. The control groups traced the maze 6 times with the preferred hand and 4 times with the non-preferred.

The instructions to the child in each case were "See, here is a game. We go around this road trying to stay inside these two black lines. Be just as careful as you can." The experimenter drew around the maze as the instructions were given and the child was then given an unmarked copy. For the second trial on each practice period the experimenter merely presented the child with a new maze and said: "Go around the road and try to stay inside the two black lines." The children were coöperative and responsive. As far as could be determined by observation the children in the practice group continued throughout the experiment to look upon the maze tracing as a game which they enjoyed playing.

RESULTS

Table 1 and figure 1 show that both the practice and control groups made large gains in average scores. The average score of each group on the initial test was 23.0. On the first end test the average score of the practice group was 30.2, a gain of 7.2. The average for the control group on the same test was 31.1, a gain of 8.1. The control group therefore gained 0.8 more than the practice group on the first end test. On the second end test the score of the control group surpassed that of the practice group by 0.3. These small differences between the two groups are not significant. The gains of each group are large, however, and so consistent for individuals—20 children gained on the first end test, 3 retained a zero score and 1 scored lower than on the initial test—that they may reasonably be considered as significant gains. The indication of these results is that the specific practice of the amount and kind given the practice group did not result in a significantly greater increase in skill than the increase found in the control group. The large increase in skill in both groups may be attributed mainly to

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* From the Washington Child Research Center.

TABLE 1

Average scores on Porteus Diamond Maze

GROUP	I	1	2	3	4	5	6	7	E-1	E-2
Practice........................	23.0	27.2	24.4	27.9	26.2	27.7	29.7	29.4	30.2	31.8
Control..........................	23.0								31.1	32.1

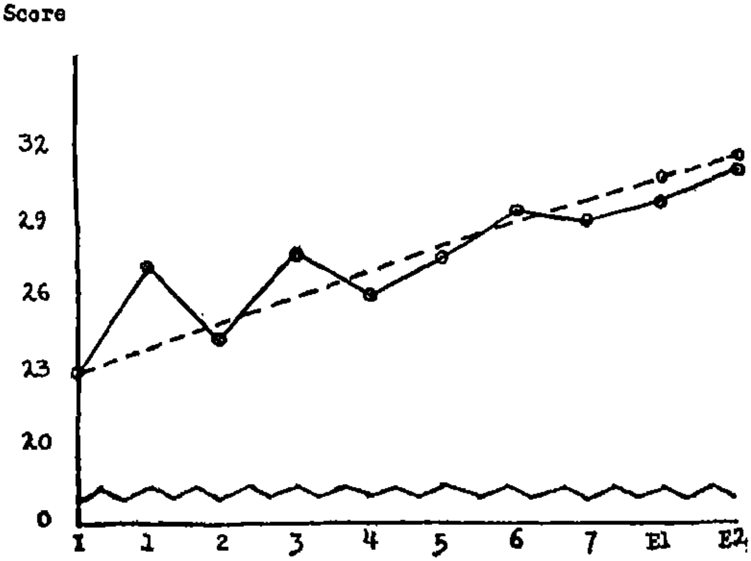

FIG. 1. AVERAGE SCORES ON PORTEUS DIAMOND MAZE

Practice group ———, control group ---------

factors such as structural maturation and general practice. These results are in accord with the findings of 2 experiments previously reported (2, 3).

Each child traced the maze twice during each test period. The effects of practice within these test periods was found by comparing the average score for the first trial on all tests with a similar average for the second trial. The average of all first trials was 27.6 and of all second trials 28.3. The difference of 0.7 in favor of the second trial is an indication that the children did slightly better on the second of 2 successive trials.

TABLE 2

Average scores on Porteus Diamond Maze with preferred and non-preferred hands

GROUP	INITIAL TEST			END TEST		
	Preferred hand	Non-preferred hand	Difference	Preferred hand	Non-preferred hand	Difference
Practice.......	23.0	19.8	3.2	30.3	18.3	12.0
Control........	23.0	17.0	6.0	31.1	22.6	8.5
All............	23.0	18.4	4.6	30.7	20.5	10.2

Table 2 shows that the difference between the average scores with the preferred and non-preferred hands on the initial test was 3.2 for the practice group and 6.0 for the control. On the end test this difference was 12.0 for the practice group and 8.5 for the control. For the combined groups the difference in scores on the two hands was 4.6 on the initial test and 10.2 on the first end test. The difference in skill between the preferred and non-preferred hands thus increased markedly over the period of time covered by this study.

J. Allan Hicks,
Dorothy W. Ralph.

REFERENCES

(1) Baldwin, B. T. and Stecher, L. I.: Psychology of the preschool child. D. Appleton. 1925.

(2) Hicks, J. A.: The acquisition of motor skill in young children. I. A study of the effects of practice in throwing at a moving target. Child Development, 1930, i, 90–105.

(3) Hicks, J. A.: The acquisition of motor skill in young children. II. The influence of specific and of general practice on motor skill. Child Development, 1930, i, 292–297.

Development of an Infant in Grasping, Reaching and Body Movements

DAY 1. At two hours, grasping reflex strong when palm of hands touched. 10. Grasping reflex less strong. 71. Grasps ribbon hung across crib, sometimes with thumb opposed. At times grasps rattle fastened to ribbon. Holds rattle with right hand, by its ring, and shakes at times. 78. Grasps rattle with one or both hands, thumb opposed. Uses right hand especially. 104. Grasps spoon with left hand (nearest hand) and cup with right (nearest), when fed orange juice. 124. Takes hold of breast and pulls to mouth. 147. Picks up toys seen, or felt in fumbling. Thumb opposed to fingers. Not always successful at first trial. Takes hold of spoon when fed orange juice or water; guides to mouth with one or both hands. 169. Reaches with both hands toward toys, dishes, etc. If one hits hand, closes fingers of both hands. Often in awkward position, such as object between two fingers. 176. Reaches for objects as small as a bead one third inch in diameter. Picks up by pushing fingers against palm.

ARM AND REACHING MOVEMENTS

Day 1. Yawn twenty minutes after birth, with stretching of arms. Random arm movements. 10. Stretches both hands above head. 15. Vigorous arm movements during bath. 19. Feel breast and clothing with fingers and palm. Sometimes one hand, usually both. 21. Lying awake, threw arms about. 24. Hands often together, fingers intertwined or one hand over other fist. 25. Hands clutch bedclothes, mother's dress, etc. Pull. 27. Rash on face. Throws arms about but seldom hits face. When strikes it, rubs with fists. 30. Reached for spoon several times, random fashion. 31. Hands usually outspread, held up over head when sleeping. 32. Definitely brings fist to mouth. 34. Pulls covers over face and sometimes cries when covered. 36. Hands pushed away bottle after "trial and error." 42. Uses hands at random, but right with greater force. Pushes bottle away. 45. Fewer random movements. 50. Reached toward towel. Pulled over face. Once reached toward white tub and smiled. Fumbles at breast and clothes of mother during nursing. Pushes spoon away with hand on side from which spoon given, other hand at same time motionless or in less motion. 59. Uses hands constantly when awake, especially pulling at bedclothes. Pushes down with hands when turned on stomach. Rubs eyes at times when sleepy. Both fists or one. Usually both arms moving. 64. When wakes in morning, is very quick in movements of arms. 71. When rattle suspended before baby, movements toward it random. 78. Rattles rattle much of waking time, usually by thrashing arms but sometimes by grasping rattle. 92. Plays with rattle, handles spoon and other objects with both hands, coördinated movement though uncertain aim. Reaches for mother's glasses and pulls off. Much random thrashing present also. At times, splashes in tub. 99. Feels one hand with other. 104. Reaches toward objects: rattle, doll, bathtub, and toilet articles, crib-cover clamps, blankets. Sometimes reaches for breast and pulls toward mouth. Both hands used. Holds armsacross shoulders of person carrying. Rubbed ear after it was cleaned, with hand on that side. Hand carried directly to ear without preceding false movements. Mother's hand pushed away with both hands on second attempt to cleanse eyes with boric acid. 120. Reaches for toes. Wiggles them and watches, especially in bath. 124. Crackles paper in two hands, pulls to mouth. Pushes spoon away when orange juice given. 135. Reaches rather aimlessly still, but less so with time. 140. Transferred rattle from one hand to other with dexterity. 147. Holds toys, celluloid or soft cloth, and crinkles and tears paper. 156. In reaching, aim rather direct but not always certain. Plays with aluminum dish cover. Pulled off cap today. Often pulls at head when cap on. Pulls off stockings and mittens. Throws right arm about in a circle. 168. Holds toy in one hand and reaches with other for another object. But tendency for hand holding toy to reach out too. 169. Given spoon, pounded on table. Dropped. Fretted and leaned over toward place where dropped. Mother handed back spoon and baby threw it and laughed. 176. Throws rattle on floor from crib but never throws other toys. Sometimes drops them. Holds two toys, one in each hand, but if holding one, drops it to get another held out to her.

BODY MOVEMENTS

Hitching and crawling

Day 59. When turned on stomach, position almost as if creeping. 104. Hitches up in crib until head hits top, when lying on back. Even more marked in carriage, where baby can push with bottom of feet. 124. Pushed across table one foot, toward milk bottle, and tipped over bottle. Whole body pushed sidewise, lying on back. 156. Crude creeping position when placed on stomach. On back, hitches shoulders and hips and moves backward quite fast.

Sitting

Day 92. In tub, pushes with feet until almost sitting up. Pushes same way in mother's lap until sitting, supported at back. Scarcely needs support. 107. Sat up in bathtub, holding on sides with two hands. Sat up when weighed for brief time. Then mother put in crib with pillows around, and baby sat up five minutes playing with toys and laughing. 113. Sits up more, supported by arm or pillows. 126. preference for sitting position, in carriage or lap. Propped up in carriage, suddenly sat upright without support, reached forward for toes, then lost balance and fell forward. Caught by mother. 135. Sat one half minute without support. 140. Sits up suddenly in carriage when propped in semi-sitting position. Can sit alone, but mother props with pillows for safety. Cannot sit up when put down on back, but raises head and feet. 155. sits alone, leans forward for toys and pushes back up. But when falls to side, frets to be helped up. Often drops forward, leaning on hands.

Turning

Day 59. Turns over from side to back, and sometimes all the way over. 64. Turns from side to side, or to back during sleep. 166. Turns completely over when on hard surface. Throws body in direction of object reached, when reaching, without regard for balance.

FLORENCE WOOLSEY HAZZARD.

Tower Building

THE cubes ordinarily used in tests of tower building are fairly large. For a more precise measurement of the child's ability to build towers the one-half inch cubes and cylinders included in Mrs. Hailmann's Beads No. 470 of Bradley's Kindergarten Material were used.

The child was seated at a small table upon which the blocks to be used were placed. He was told to build a tower as high as he could. The observer demonstrated the building then placed the blocks back in the group. If the child stopped after a few blocks were placed he was encouraged to put other blocks on. A record was kept of the time taken for the building and of the number of blocks placed. The cubes were presented first. After a brief interval for changing blocks the cylinders were presented. This procedure was repeated after an interval of a month. The reactors included 25 children ranging in age from twenty-nine to sixty-one months, and 9 adults who were graduate students.

In table 1 the scores are given for the number of blocks placed and for the time required in the placing. The largest number of cubes placed by an adult was 12 but one child succeeded with 13 cubes. No adult placed fewer than 10 cubes and 2 of the youngest children succeeded in placing only 4 cubes. This wide range of placements for the children gives them an average of 8.2 cubes placed in comparison with 11.4 for adults. The time required is a function of the number placed though wide differences in time required for the same number of blocks are found. The range of time scores for adults is from 18 seconds for 10 cubes to 41 seconds for 12 cubes; for children from 7.4 seconds for 4 cubes to 178 seconds for 13 cubes. Despite three long time scores the children show an average time of 38.1 seconds to be compared with 27.3 seconds for adults.

The cylinders offered greater difficulty to both groups. The ability of the children in number of cylinders placed and in time required approaches more closely the adult performance than with the cubes.

The second trials by the children show an improvement in the time required for the cubes but approximately the same average for number placed. For the cylinders the time required is slightly longer than on first trail and the average for placements is slightly higher.

It would seem advantageous for the differentiation of abilities of children that the larger blocks frequently used in mental measurements of children under 6 years of age should be replaced by smaller ones. The limitation of the number to be placed to less than 10 does not offer an opportunity to the child of superior skill to display his abilities.

BUFORD JOHNSON,
DOROTHY MOORE COURTNEY.

TABLE 1

Tower building

CHILD	CHRONOLOGICAL AGE		TRIAL 1				TRIAL 2			
	Years	Months	Cubes		Cylinders		Cubes		Cylinders	
			Number	Time	Number	Time	Number	Time	Number	Time
1	4	8	11	30	6	30	10	35	8	125
2	5	0	9	19	4	6	10	28	5	14.4
3	4	6	8	18.6	5	14.2	7	18	5	24
4	4	4	9	23	4	8.2	11	34.8	6	14.4
5	4	4	10	20	6	14	6	10.2	5	15
6	4	10	13	178	8	52.4	13	82.4	9	44.6
7	4	5	10	42	5	14	9	21.6	5	10.8
8	4	9	7	20.2	6	22.2	6	16.8	4	18
9	3	7	6	12	6	10.6	6	15.4	6	16
10	4	3	12	30.2	5	7.8	11	46.4	8	55
11	4	7	6	14.4	5	11.4	7	28	6	10.8
12	3	8	9	81.4	7	30.2	9	60.6	5	10.8
13	4	10	8	17.4	5	14.4	7	20.2	6	10.6
14	4	0	7	31	6	17.2	9	63.6	5	17
15	3	10	9	52.2	5	15	9	36	6	10
16	3	10	9	41	6	15.4	11	57	5	19.4
17	5	1	8	18.8	5	10	9	30	8	21
18	4	3	7	20.2	7	33.8	7	17	6	15
19	2	8	8	35	5	29.2	5	81	5	36.2
20	2	8	4	24.2	4	32.2	9	47	5	31.4
21	3	0	8	47	5	20.6	6	17.4	4	8.4
22	2	5	4	7.4	3	63.4	5	11	7	7.2
23	4	2	11	54.6	4	6.4	8	52	5	12
24	3	6	7	90	6	26.2	8	40	5	25
25	3	4	5	11	4	11.6	5	9.8	4	6
Average			8.2	38.1	5.28	20.6	8.18	35.1	5.5	23.6
ADULTS										
1			12	41	8	40				
2			10	26.8	5	16				
3			12	24	7	16				
4			12	25	7	15				
5			11	20.4	8	14				
6			10	18	6	11.2				
7			14	31	7	19.8				
8			12	36.8	9	30.8				
9			10	23.8	5	10				
Average			11.4	27.3	6.8	19.1				

A Study of Factors Affecting the Amount and Kind of Food Eaten by Nursery School Children*

MARION ELIZABETH DUNSHEE

EVER since the opening of the nursery school of the Institute of Child Welfare, University of Minnesota, daily records have been made of the food and eating habits of children at the lunch hour. In the present study 3005 such records made on 37 children between the months of January and July 1927 were analyzed to determine factors influencing the amount and kind of food eaten at this noonday meal.

Because the nursery school movement is so new, completed research on children in such institutions is meager, and a search of the literature has revealed no study of the precise nature of the present one. Imlay (19) conducted a study of the food consumption and food habits of young children and studied the extent to which those habits might be modified by the nursery lunch. She made a home study of the children at meal time, determining the amount and kind of food eaten, as well as their attitude toward the food. The lunch at the nursery school was very carefully balanced as to nutrients and adequate in calories. The same kind of records were kept as those made in the homes. A similar study was made by Barker (5), of the group lunch as a means of solving some problems in feeding the pre-school child. She secured her data by means of questionnaires, observations, and studies of 12 nursery school children over a period of two months. Sholley (28) made an analysis of nutritional and management problems of 400 children in the pre-school clinics of the Infant Welfare Society of Minneapolis.

Roberts (23) reports a detailed study made by herself and Moseley on reactions to food of children of pre-school age, with special consideration of management as a conditioning factor. One hundred children were observed in their homes through at least one meal and a record was made of the child's attitude, reactions, and the factors influencing his eating. A ques-

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* Acknowledgment is made of indebtedness to the forty-six students in the course in Field Work in Nutrition, whose carefully kept records of the food and eating habits of the nursery school children during their lunch hour furnished the original data for this study.

Appreciation is expressed of the careful examination and criticism of the manuscript by Dr. John E. Anderson, Adviser and Chairman of the Thesis Committee.

Especial acknowledgment is made of the grant of a Laura Spelman Rockefeller Fellowship for the year 1927-28.

tionnaire was also taken from the mother concerning the factors in his earlier years which might account for his present attitudes. In June, 1927, Sweeney (29) states that a series of studies were initiated at the Merrill-Palmer School involving "the evaluation of the nursery school atmosphere, the standards of service, the appearance of the food and the influence of the nursery school personnel." The details of the studies are not evident from the report and it appears that they are not completed.

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General record of food and eating habits of nursery school children at lunch

Sat down at..........Left table at..........Name of child..............................Date..............................

FOOD	KIND	AMOUNT	EXTRA	AMOUNT UN-EATEN	ATTITUDE				URGED	HELPED TO FINISH
					With relish	As matter of course	Disliked but ate	Refused		
Vegetable cooked										
Vegetable uncooked										
Potato or substitute										
Protein food										
Sandwich										
Crusts										
Milk										
Dessert or fruit										

A. Appetite: very hungry, hungry, indifferent, little, none.
B. General attitude: alert, normal, fatigued, sleepy.
C. Attitude toward other children: disregarding, matter of fact, interested, distracted, disturbed whom.............................. disturbed by..............................
D. Attitude toward visitors: unaware, casual, aware, distracted.
E. Attitude toward adult at table: demonstrative, matter of fact, ignored, antagonistic.
F. Conversation at table: none, quiet, normal, talkative, very talkative.
G. Bodily activity during meal: very quiet, quiet, average, restless, very restless.
H. Ability to feed self:
1. Spilling: none, little, much.
2. Handling of utensils: Knife...................., fork...................., spoon....................
I. Manner of eating: eats rapidly, at average speed, slowly. Child is first through in room, last through in room. Takes: very small bites, average bites, large bites.
J. Serving food: Coördination: very good, good, average, poor, very poor Spilled.............................. Dropped..............................
K. Training method used: Praise, favorable comparisons, critical comments, timing, reward, example, others..

The records used in this study were kept by students in the course in field work in nutrition, under the supervision of Dr. Jane Leichsenring. Each student ate lunch at a table with three of the children and during the meal or immediately after filled out a record blank for each child. The record blank will indicate what the student had to report: the kind of food, the amount eaten, the attitude of the child toward the food, whether he had to be urged, or helped, his attitude toward various people in the room, and his general reaction to his environment. Since this study extended over two quarters and a summer term of school, it was inevitable that the personnel of the students would change several times, with the result that forty-six students made the 3005 records. Furthermore not all the children were present from the beginning of the period. For that reason the range in number of records is large, from 22 to 108 with a mean of 81.5.

For the purpose of analysis these data were approached from two angles: (a) a study of the factors affecting the amount of food eaten, and (b) a study of the factors affecting the kind of food eaten.

AMOUNT OF FOOD EATEN

Since the amount of food eaten was expressed in various units of measure such as fractions of a cup, slices (of bread), or numbers of pieces, it was decided to convert the amount of food into terms of calories. Accordingly the caloric value of all the food used was determined, and from these data the total number of calories consumed by each child each day was computed and the mean amount for each child estimated. These data furnished a basis for studying the following factors which conceivably might influence the amount of food eaten: age, sex, time spent at the table, the person in charge of the table, the child's attitude toward his food, the season of the year, the child's activity, and the training methods used.

KIND OF FOOD EATEN

The second part of this study was concerned with the factors affecting the kind of food that the nursery school children ate. So far as the kind of food placed before him was concerned the child had no choice, but whether or not he ate the food was a different matter. When the children's attitudes toward food were worked out it became evident that the percentages of refusals and of "disliked but ate" were very low indeed; a mean of 2.23 per cent for refusals and 3.25 per cent for dislikes. These records were analyzed to determine, if possible, the factors responsible. The foods were divided into five major groups: milk, protein foods other than milk, vegetables, carbohydrate foods, and desserts and the number of refusals of each food within each group tabulated and summarized. From these data the total number of refusals for each food was obtained and the percentage of times refused in relation to the number of times offered was estimated. A like process was followed in the case of the records of "disliked but ate." The records of the refusals and "disliked but ate" in percentages were then summarized.

Since this study began with records which were made January nineteenth, and most of the children had been in the nursery school at least since fall, and in a number of cases longer, it was reasonable to suppose that the attitude toward their food had been influenced by this residence. To determine its affect, correlations were made between each attitude and the length of nursery school attendance. Partial correlations were made in which age was held constant for nursery school attendance and the attitudes "with relish," "matter of course," and "refused." The correlation between nursery school attendance and the attitude "disliked but ate" showed so little relationship that age was not partialled out.

RESULTS

In a consideration of the results of this study it is necessary to keep some of the limitations of the data in mind. The number of cases is small, 37, and for that reason the results may be considered to point out general tendencies only. The period of time covered does not take in the fall months, the inclusion of which might show greater seasonal differences in the amount of food eaten and the number of refusals made.

Inspection of the standard deviations in table 1 shows a wide dispersion from the mean number of calories eaten in a number of cases. In all instances this was due to one or two cases at the upper or lower extremities of the distribution. Unquestionably, this fact reduces the reliability of the results. In all correlations the means were used. This was a shorter method but somewhat less accurate than if the original day's records had been used. The expression of the time that the children ate "with relish" etc. in terms of percentages also influences the correlations, for it stands to reason that if the child eats with relish 85 per cent of the time he cannot assume the other attitudes more than a total of 15 per cent of the time.

TABLE 1

Means and standard deviations of calories per meal per child

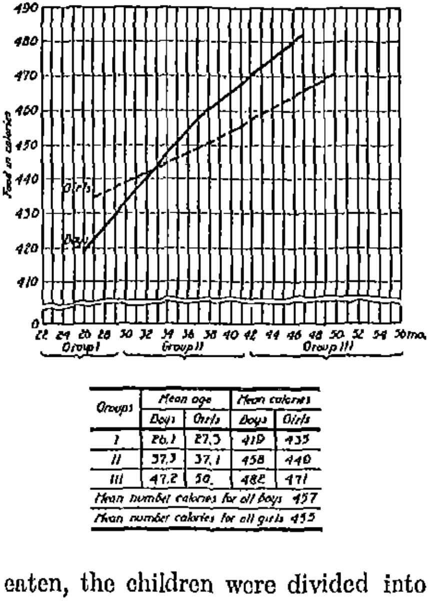
CHILD	AGE	MEAN	S.D.
	months		
David B.	37	430	72.5
Mary B.	27	443	61.5
David Bu.	48	473	65
Joe C.	22	440	68
Gwendolyn C.	38	451	67.5
Robert DeL.	43	477	67.5
Anna D.	43	440	115
John E.	29	400	112.5
Quentin E.	37	470	57.5
Mary F.	28	423	62.5
Donald F.	35	468	45
Ray F.	44	457	65
Robert G.	30	453	75
Elaine H.	41	472	72.5
Pollyanna J.	27	450	65
Harriet L.	56	460	80
Irene LaV.	33	383	92.5
Paul L.	56	480	47.5
Richard L.	39	453	82.5
Clayton L.	47	475	70
Roger L.	33	454	72.5
John L.	44	555	105
Grace M.	35	453	87.5
Margaret P.	46	433	77.5
Helen P.	52	488	62
Dorothea Q.	31	417	86.5
Dorothy Q.	50	508	85
Robert Q.	27	455	50
Lawrence S.	51	485	55
John S.	20	433	91.5
Richard S.	45	487	80
Catherine S.	41	489	70
John T.	22	351	110
Joan W.	53	488	67.5
Claire W.	41	470	85
Mary W.	41	478	70
Richard W.	28	440	75

Factors affecting the amount of food eaten

Table 1 gives the means and standard deviations of calories per meal for each child. It shows not only great variability for individual children, but also considerable variation within the group, a fact which comes out in all the factors studied.

Age and sex. To study the influence of age and sex on the amount of food eaten, the children were divided into three age groups: the first, from 1 year and 6 months to 2 years and 5 months; the second, from 2 years and 6 months to 3 years and 5 months; and the third, from 3 years and 6 months to 4 years and 8 months. These groups in turn were divided according to sex. That gave 3 girls and 6 boys in the first group 8 girls and 8 boys in the second group; and 6 girls and 8 boys in the third group; making a total of 16 girls and 21 boys. These groups are small, but when the number of records is considered (table 2) the results may be given some weight. The mean number of calories by age and sex are shown in fig. 1 and the accompanying table.

Fig I
Relationship between age and mean number of calories, by sex.



Groups	Mean age		Mean calories	
	Boys	Girls	Boys	Girls
I	26.1	27.5	419	435
II	37.3	37.1	458	440
III	47.2	50.	482	471
Mean number calories for all boys 457				
Mean number calories for all girls 455				

There are slight differences in the mean number of calories eaten by Group I and Group II, and between Group II and Group III, but the difference only becomes statistically significant when Groups I and III are compared. Here the difference divided by its standard error is 4.17. The sex difference in Group I, as shown by the difference divided by the standard error of a difference is 1.03; in Group II, .64; and in Group III, .91; indicating that there is no significant difference. When all the boys are compared with all the girls the difference becomes still less significant, with a mean of 455 and a standard deviation of 31.3 in the case of the girls and a mean of 457 and a standard deviation of 28.6 in the case of the boys.

Time spent at the table. Table 3 shows that the average length of time spent at the table during the period studied ranged from 21 to 49 minutes, with a mean of 34 and a standard deviation of 6.32 for the group as a whole. This makes an average of considerably less than 45 minutes, as given by Barker (5).

The correlation between the mean amount of time spent at the table and the mean number of calories eaten per day (−.65 ±.06) (table 4) would tend to show that in general the child who stays at the table longest eats less food. This coincides with the general impression that the child who dawdles or plays with his food eats comparatively little and that the child who enjoys his food eats more and eats it more rapidly. The correlation between the length of time spent at the table and age is −.43 ±.12 and when age is held constant the correlation between the length of time spent at the table and the mean number of calories eaten per day becomes −.55. It would appear then that age is a slight factor, but that there is a significant, although not high, degree of negative relationship between the time the child spends at the table and the amount of food he eats.

TABLE 2

Number of records upon which data are based

Age	1:0–2:5				2:6–3:5				3:6–4:8			
Sex	Boys		Girls		Boys		Girls		Boys		Girls	
	J. C.	38	M. B.	81	D. B.	97	G. C.	78	D. B.	94	A. D.	98
	J. E.	73	M. F.	49	Q. E.	105	E. H.	106	R. D.	78	H. L.	81
	R. Q.	95	P. J.	70	D. F.	72	I. L.	89	R. F.	54	M. P.	62
	J. S.	95			R. G.	98	G. M	73	P. L.	68	H. P.	82
	J. T.	22			R. L.	88	D. Q.	45	C. L.	93	A. D.	98
	R. W.	89			R. L.	85	C. S.	103	J. L.	62	J. W.	93
					C. W.	97	M. W.	92	L. S.	88		
									R. S.	108		
Number of records		412		200		642		596		645		514
Grand total												3,005

TABLE 3

Means and standard deviations of time spent at the table

CHILD	MEANS	S.D.	CHILD	MEANS	S.D.	CHILD	MEANS	S.D.
	minutes			*minutes*			*minutes*	
David B.	42	9.22	Robert G.	31	6.22	Helen P.	33	6.71
Mary B.	35	8.95	Elaine H.	29	7.07	Dorothea Q.	41	9 75
David Bu.	35	7.75	Pollyanna J.	34	8.06	Dorothy Q.	26	6.71
Gwendolyn C.	36	11.18	Harriet L.	35	7.42	Robert Q.	29	7.75
Gwendolyn C.	36	6.89	Irene LaV.	47	10.73	Lawrence S.	21	7.07
Robert DeL.	26	6.89	Paul L.	29	6.52	John S.	35	10.25
Anna D.	37	8.95	Richard L.	36	11.18	Richard S.	32	7.42
John E.	41	11.83	Clayton L.	26	5.70	Catherine S.	37	7.07
Quentin E.	32	6.13	Roger L.	31	7.07	John T.	44	7 07
Mary F.	45	10.25	John L.	29	7.07	Joan W.	25	6.33
Donald F.	29	8.37	Grace M.	30	9.75	Claire W.	26	6.89
Ray F.	35	8.66	Margaret P.	49	10.95	Mary W.	30	8.37
						Richard W.	33	8.06

Range of mean amount of time spent at the table 21 to 49 minutes
Mean 34 minutes S.D. 6.32 minutes

TABLE 4

*Correlations**

	r	P.E.	PARTIAL CORRELATIONS, AGE CONSTANT
I. Mean number of calories per day with:			
Time spent at the table	–.65	±.06	–.55
Length of nursery school attendance	.40	±.09	.017
Percent of time food eaten "with relish"	.68	±.06	.67
Percent of time food eaten "as a matter of course"	–.57	±.07	–.50
Percent of time food "disliked but ate"	–.39	±.10	
Percent of time food was refused	–.62	±.07	–.58
Number of urgings	–.53	±.08	–.50
Number of times help was given	–.44	±.09	–.42
Bodily activity	.11	±.11	.057
Conversation at the table	.37	±.09	.016
Attitude toward other children	.12	±.11	–.21
Attitude toward adult at table	.23	±.10	.014
Attitude toward visitors	.20	±.11	.03
Praise	.18	±.11	
Favorable comparison	.15	±.11	
Critical comment	.23	±.11	
Timing	–.33	±.10	
Reward	.09	±.10	
Example	–.24	±.10	
II. Age with:			
Mean number of calories	.70	±.06	
Time spent at table	–.43	±.12	
Length of nursery school attendance	.56	±.07	
Percent of time food eaten "with relish"	.33	±.09	
Percent of time food eaten "as a matter of course"	–.33	±.09	
Percent of time food "disliked but ate"	.02	±.11	
Percent of time food was refused	–.33	±.09	
Number of urgings	–.25	±.10	
Number of times help was given	–.22	±.10	
Bodily activity	.10	±.11	
Conversation at the table	.51	±.08	
Attitude toward other children	.37	±.09	
Attitude toward adult at table	.32	±.10	
Attitude toward visitors	.32	±.10	
III. Number of urgings with:			
Percent of times refused	.99	± 006	
Percent of times "disliked but ate"	.70	±.06	
IV. Nursery school attendance with:			
Percent of times food eaten "with relish"	.30	± 09	.27
Percent of times food eaten "as matter of course"	–.31	±.10	–.16
Percent of times food "disliked but ate"	– 22	±.11	
Percent of times food was refused	– 31	±.10	–.16

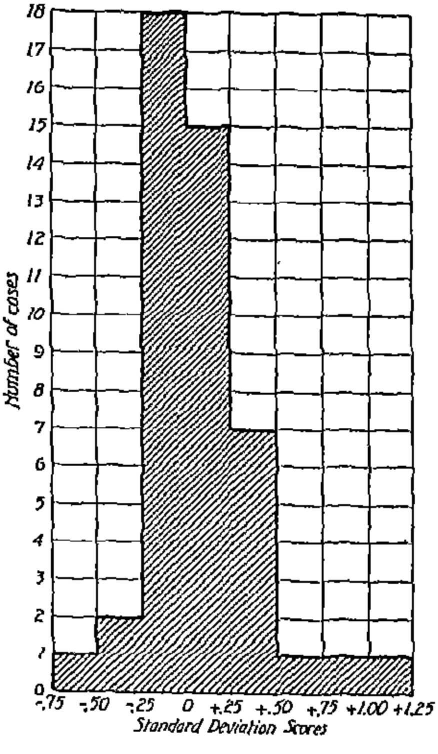
* The Pearson product moment formula was used.

The person in charge. A casual observation of the student in charge of the table would convince one that she was a factor in the amount of food the child ate. This problem was complicated by the fact that there were so many different students in charge. One child had as many as 17 people making records on his food and eating habits, whereas another had but two. The average was seven. Moreover, the number of records made on a given child by the different recorders varied widely. Donald F. had 11 recorders, nine of whom made from 1 to 6 records, and one making as high as 35. The situation was equally complicated when the number of children on which each student made records was considered. Here there was a range from three to twenty-five, with the mean falling at seven.

Two methods for studying the teacher's influence were at last decided upon. (1) The mean number of calories which each child ate when with a given recorder was estimated and converted into his standard deviation score when with that recorder, and then the recorder's standard deviation score was determined. (2) The second method was to use the records of the four people who made reports on the largest number of children (M.M., 25; C.T., 18; H.H., 22; and S.P., 20). In each case the mean amount of food eaten when with the recorder was figured and also the mean amount of food eaten when with all other recorders. The number of cases was so small that the relationship between these means was found by using the Spearman rank order correlation. An examination of the standard deviation scores for individual children revealed that the recorders had a very definite influence on the amount of food the children ate. There were few children whose records indicated no influence.

Fig. 2 gives the distribution of the recorders' standard deviation scores and shows the individual differences at a glance. In 25 cases the recorders tended on the average, to increase the amount of food eaten, although it ranges from the practically negligible increase of +.01 to +1.06. In the case of those recorders who tended to decrease the amount eaten the figures vary from −.002 to −.70. However,

Fig. 2
Distribution of Recorders' Standard Deviation Scores



the majority of instances fall between +.28 and −.25.

The results of the second method used to show the influence of the person in charge on the amount of food the children ate are given in table 5. In all four of these cases the correlations between the mean number of calories eaten when with a given recorder and the mean number of calories eaten when with all other recorders are so small and their probable errors so large that there is little relationship between the two. The standard deviation scores of these individuals show somewhat the same tendency. When with M.M. the children tend to eat more than their average (+.26); when with C.T., more than their average (+.13); when with H. H., less than their average (−.16); and when with S.P. about the same (−.01).

The length of nursery school attendance. There was a wide range in the children's attendance at the nursery school, from 22 to 292 days, with a mean of 158 and a standard deviation of 74.8. If the general opinion is true (8), (12), (20), (21), one might expect a fairly high correlation between the length of attendance and the number of calories eaten. The correlation (table 4) as shown by the coefficient is +.40 ±.09. This indicates, of course, that there is a definite positive relationship, but it is not very high. The correlation between age and nursery school attendance is +.56 ±.11 (table 4) and when age is held constant the coefficient between length of nursery school attendance and mean amount of calories per day becomes .017. It would appear, then, that age is the factor present and that there is practically no relationship between the length of nursery school attendance and the amount of food eaten.

The children's attitude toward their food. Percentages of all the records of attitude reported as "with relish," "matter of course," "disliked but ate," and "refused," and number of times the individual was urged or helped were computed for each child. These percentages showed that in the largest percentage of instances the children ate their food with relish; that in the majority of cases when the children did not eat with relish, their attitude was reported as "matter of course." In only a very low percentage of cases were refusals made or was the attitude "disliked but ate" assumed. Table 6 shows this situation still more clearly. On an average 68 per cent of the time the children ate with relish; 26.8 per cent as a matter of course; 3.25 per cent of the time they "disliked but ate" the

TABLE 5

Correlations between the mean number of calories eaten when with a given recorder and the mean number of calories eaten when with all other recorders

NUMBER OF CASES	RECORDER AND ALL OTHER RECORDERS	r	P.E.
25	M. M. and all other recorders	.01	±.16
18	C. T. and all other recorders	.08	±.16
22	H. H. and all other recorders	.13	±.12
20	S. P. and all other recorders	.19	±.15

food; while only 2.23 per cent of the time was it refused.

The correlations brought out some interesting relationships (table 4). The coefficient for the per cent of time that food was eaten with relish and the mean number of calories eaten was .68 ±.06, signifying that when children ate with relish they tended to eat more. When age was partialled out the coefficient was .67, so that age would seem to be a negligible factor in this instance. The coefficient of correlation between the per cent of time the food eaten "as a matter of course" and the mean amount of food eaten (−.57 ±.07) indicates a fair degree of negative relationship; with an increase in the amount of food eaten the attitude of "matter of course" decreased in per cent. This is what might be expected in the light of the results for the amount of food and the attitude "with relish." Holding age constant, the coefficient became −.50 so that age may be a small factor.

TABLE 6

Means and standard deviations of attitude toward food

	PER CENT WITH RELISH	PER CENT MATTER OF COURSE	PER CENT DIS-LIKED BUT ATE	PER CENT RE-FUSED
Mean...........	68	26.8	3.25	2.23
S.D.............	14.83	11.83	2.4	2.09

The coefficient for "disliked but ate" and the amount of food eaten (−.30 ±.10), while not very high, shows a negative relationship which one might expect,—as the dislike for food increased the amount eaten decreased. There is no relationship between age and the attitude "dislike but ate," as shown by the coefficient of correlation .02 ±.11, therefore age was not partialled out. The relationship between the per cent of refusals and the amount of food eaten (−.62 ±.07) is a fairly large negative one as might be anticipated,—when the per cent of refusals increased the amount of food eaten decreased. With age held constant the relationship becomes −.58; therefore it would appear that age is not important. Coefficients between the number of urging and the amount of food eaten (−.53 ±.08), and the number of times help was given and the amount of food eaten (−.44 ±.09), both show the type of relationship one would look for. Age appears to be a very minor factor in both cases, for when it is held constant —.53 becomes —.50 and —.44, drops only to −.42.

Season. A comparison of the mean amount of food eaten in a three weeks winter period and that eaten in a like period in summer brings out some interesting points. Of the 23 children studied 15 ate less in the summer period than in the winter period, 7 ate more, and 1 ate the same amount. For only three of the children who ate less in summer is the difference statistically significant; and exactly the same number of children ate a significantly greater amount in summer. One may conclude, then, that in these cases studied there is no significant difference in the amount of food eaten during the winter and summer seasons. These findings are interesting in the light of Clayton's (9), quoted above, in which she finds no seasonal variation in growth. They also point to the value of well-balanced meals (26) which are always served at the nursery school.

Bodily activity during the meal. As will be noted, five degrees of activity were reported upon. Each activity was weighted, the values increasing with increase in activity; i.e., very quiet was given a value of 1; quiet, 2; average, 3; restless, 4; and very restless, 5. From these data a final activity score for each child was evolved by dividing the sum of his daily ratings by the number of records. When the scores for bodily activity were correlated with the mean amount of food eaten (table 4) a coefficient of .11 ±.11 was obtained, showing that there is very little relationship between the two. This is interesting because from casual observations one might infer that the lively children were not still long enough to eat very much. A coefficient of .10±.11 was obtained between bodily activity and age, and when age was partialled out the coefficient between bodily activity and mean number of calories became negligible (.057).

Conversation at the table. Although in the majority of cases the children were reported as either normal or talkative, nevertheless the ratings were treated in the same way as those on activity. In the weighting increasing values were given to the points indicating more conversation: none received a value of 1; quiet, 2; normal, 3; talkative, 4; and very talkative, 5. When the final scores for conversation were correlated with the mean amount of food the children ate (table 4), a coefficient of .37 ±.09 was obtained. Thus there seems to be some positive relationship between the amount of food eaten and conversation. There is a higher positive relationship, however, between the amount of conversation at the table and the age of the children (.51 ±.08). Moreover, when age is held constant the coefficient .37 becomes .016, so that one may assume that age is probably the significant factor in the relation between food consumption and conversation at the table.

Attitude toward other children. Little children are very much interested in one another. When they are gathered together as they are during the nursery school lunch period, are they so distracted by one another's presence that it interferes with the amount of food they eat, or is there no effect? The records which were kept make it possible to answer this question in the case of this nursery school. The student reported the child's attitude according to the following points: disregarding, matter of fact, interested, distracted, disturbed by, disturbed whom. These data were treated as in bodily activity, the weighting being done according to degree of distraction. The correlation between the final scores on attitude toward other children and the mean number of calories eaten (.12 ±.11) (table 4) shows that there is not much relationship between the two. When age is held constant a low negative relationship (−.21) is evident. For the most part, then, there is no connection between the amount of food eaten and degree to which the children may be distracted by one another.

Attitude toward adult at the table. Another way of getting some idea as to the influence of the student on the children at her table was made possible by the records kept on the child's attitude. Four possible attitudes were given: demonstrative, matter of fact, ignored, and antagonistic. These data were also treated like those on bodily activity. The weighting was done so that the value increased with the increasing attention the child paid to the student. Individual scores showed that most of the time the children were matter of fact in their manner toward the student in charge; they were frequently demonstrative, but seldom ignored or were antagonistic. When the score on this attitude was correlated with the mean amount of food eaten there appeared to be comparatively little relationship (.23 +.10). Here again, when age was held constant the relationship became negligible (.014).

Attitude toward visitors. Since the nursery school at the Institute is a research center and serves as a laboratory for study of the young child, there are a good many visitors during the course of the year. In fact it is an exceptional day when six or eight adults are not seated in each room during the lunch hour. They are requested to make themselves as inconspicuous as possible but under the best of circumstances one may question as to whether or not their presence is a disturbing factor. With the idea of determining just how distracting the visitors might be, the child's attitude toward visitors was included in the record. Four conditions were listed: unaware, casual, aware, and distracted. In working up the data the writer tabulated the material as in bodily activity. In the weighting, the values were graded according to the increasing degree of distraction. Each child's final score was correlated with his mean number of calories per meal (table 4). In most instances the children were either unaware of the adults or assumed a casual attitude toward them. The coefficient of correlation (.20 ±.11) between the scores on the attitude toward visitors and the mean amount of calories eaten reveals low relationship between the two. There is a closer relationship between the scores obtained on attitude toward visitors and age (.32 ±.09), and when age is held constant the relationship between attitude toward visitors and amount of food eaten practically disappears (−.03).

The effect of the training method used. Individual scores for the use of each training method were worked out in percentage. Of the six methods praise was used most often, favorable comparison next most often, and the other four methods—critical comment, timing, reward, and example—were employed approximately an equal number of times. Generally speaking, the correlations between these various training methods and the average amount of food eaten indicate little relationship (table 4). The correlations with praise (.18 +.11), favorable comparison (.15 ±.11), and critical comment (.23 +.11), have such high probable errors that the relationships become negligible, that with reward (.09 ±.11) is so small as to show practically no relationship, and those with timing (−.33 ±.10) and with example (−.24 ±.10) express some negative relationship, but here, too, the probable errors are so high that the correlations lose their significance. One seems justified in concluding that, on the whole, there is little connection between the amount of food these nursery school children ate and the different methods of training employed.

TABLE 7

Influence of various factors on mean number of calories eaten

	GROUP A 10 CHILDREN WHO ATE MOST		GROUP B 10 CHILDREN WHO ATE LEAST	
	Mean	S.D.	Mean	S.D.
Calories	494	21.9	414	20.8
Age in months	47	5.91	32.0	7.25
Time at table (min.)	20	4.33	41	5.0
Attitude toward food:				
Percent with relish	78.0	9.7	53.0	11.2
Percent matter of course	18.0	7.7	38.0	9.58
Disliked but ate	2.2	1.64	5.2	9.57
Refused	0.6	0.03	3.9	2.71
Urged to eat	10	3.59	18.9	13.0
Helped	2.3	3.59	18.9	13.0
Attendance	108	54.6	109	52.37
Activity	3.16	1.28	3.13	4.89
Conversation	3.01	.42	3.11	.24
Attitude to other children	3.14	.33	2.07	.5
Attitude to adult	3.26	.20	3.06	.18
Attitude to visitors	1.49	.26	1.30	.23
Training methods:				
Praise	35.5	11.45	34.7	11.44
Favorable comparison	23.5	5	21.8	0.10
Criticism	10.3	5.39	8.0	5.38
Timing	10.0	5.0	15.5	0.7
Reward	13.8	4.33	11.5	4.89
Example	7.6	4.0	8.0	5.74

The relative influence of various factors on the mean number of calories eaten. With the purpose of checking the correlations and confirming the relationships already obtained the 10 children eating the most food were compared with the ten eating the least. The two methods yielded very similar results. (See table 7.) The children of Group A ate more food on the average than those in Group B; they are also older than Group B; both facts are in agreement with the correlation between age and mean number of calories eaten, .70 ±.06. The children who spend the shortest time at the table (mean, 29 minutes) are Group A; those who stay at the table longest (mean, 41 minutes) are Group B. These confirm the correlation of −.65 between the time spent at the table and mean number of calories eaten. The percentage of records showing that children ate with relish is higher for Group A; while Group B exceeds Group A in per cent of records in each of the three unfavorable attitudes, matter of course, disliked but ate, and refused, urged and helped. All these differences are consistent with the correlations reported in table 4.

The children who have attended the nursery school the longest (mean, 198 days) are those who eat the most (Group A), and those who have attended the nursery school the shortest length of time (mean, 109 days) eat the least (Group B). This data shows a somewhat higher relationship than the correlation +.40 ±.09. However, it may be that since these children are the older children, age is the chief factor, as would be indicated by the partial correlation, .017.

The group of hearty eaters differed very little from the group of light eaters in the mean ratings for bodily activity, attitudes toward other children, adult at the table, and visitors, and the correlations between food consumed and these factors are correspondingly low. Likewise the two groups differ little in the extent to which praise, favorable comment, criticism, reward, and example were used as a training method, and again the correlations on these factors are low.

Group A shows a higher percentage of talkativeness than Group B, but from the low partial correlation one may suspect that age rather than amount of food eaten is the important factor here. The negative correlation between timing as a training method and food consumption is consistent with the fact that this method is less often used with Group B than with Group A.

Since these two methods of showing relationship, that of correlation and that of obtaining differences between two groups at the extremes, check so closely, it is safe to assume that the results obtained are fairly accurate for the group of children studied.

Factors affecting the kind of food eaten by Nursery School Children

The second part of this study is concerned with the factors affecting the kind of food that the nursery school children ate. Obviously a big factor is the kind of food that is offered them. The meals which were served at the nursery school of the Institute were planned under the direction of the Division of Nutrition, Department of Home Economics of the University of Minnesota. These meals were simple, well-balanced, and took into account all the food nutrients necessary for the maintenance and growth of the preschool child (26).

Sample menus picked at random

I

January 31
Scrambled Eggs
Scalloped Potatoes
Buttered Peas
Lettuce Sandwich
Milk Peach Sauce

II

April 13
Rice and Tomato
Creamed Cabbage
Peanut Butter Sandwich
Milk
Fruit Gelatin Thin Cream

III

May 27
Creamed Fish
Baked Potatoes
Buttered Cabbage
Plain Sandwich
Milk Peach Sauce

IV

June 20
Egg Souffle
Buttered New Potatoes
Creamed Carrots
Lettuce Sandwich
Milk Pear Sauce

The four sample menus above have been picked at random from the meals served these children, and are representative of the type given. A protein dish, eggs, fish, meat, or cottage cheese, was practically always served. In a few cases—when they had soup, or, as in Menu No. II, where the main dish was rice—the protein was provided in some other form, the peanut-butter in the sandwich, for example. Potatoes, a green vegetable (creamed or buttered), sandwiches, milk, and a simple dessert, usually fruit or milk dessert, constituted the rest of the meal.

The order in which these meals were served should be considered. The vegetable, which is rather generally thought to be the least liked of foods, (5), (18), (19), (23), was served first. This practice was instigated with the idea that when an individual is hungry he is more apt to eat food which he dislikes than at other times. The main part of the meal followed, and then the dessert. Measured portions of food were given the children, and the larger children were give somewhat larger amounts. Of course the children had second helpings if they wished.

In the light of the general conditions of the nursery school, the results in the study of the factors influencing the *kind* of food eaten are interesting indeed. Inspection of table 6 shows that on the average, 68 per cent of the time the children ate their food with relish and 26.8 per cent of the time as a matter of course. Plainly, if one eats his food with relish he likes it, and if he eats it as a matter of course he may be considered to have no aversion to it and, doubtless, in most cases has a mild liking for it. Therefore, it seems that one might assume that 94.8 per cent of the time the children ate their food because they liked it. The rest of the time the children were reported as having refused the food or eaten it although they disliked it. The percentage of refusals was very low (2.23). In the light of the common impression of children's food idiosyncracies, an examination of these refusals is enlightening.

Of the 3005 times that milk was offered (table 8), only 22 times was it refused, making a percentage of refusal of .73. And yet mothers frequently state that they find it a big problem to get their children to drink milk. Protein food other than milk was refused but 37 times. The highest percentage of refusals was of eggs, the next highest of fish, and the lowest of meat. However, the small differences in percentage could hardly be considered significant. The total number of times that all vegetables were refused was 47 or 1.56 per cent and the number of times that each individual vegetable was refused was so low that no comparison of the different vegetables could be made. Evidently these children liked vegetables, although the fact that they were served before any other food was given may in part account for the few refusals. These results are illuminating when the studies of Sholley (28), Barker (5), and Imlay (19) are examined. Sholley states, "Vegetables prove the stumbling block for many children. Probably mothers experience more difficulty getting children to eat vegetables than any other item of the diet." In her conclusion Barker says that her findings showed that every child studied presented some problem so far as vegetables were concerned, and Imlay maintains that "vegetables are the most generally disliked of all classes of foods." All three of these studies included the home situation as well as the nursery school or the preschool clinics. Carbohydrate foods were refused only seventy-four out of 5932 times they were offered which gives a percentage of refusal of 1.24; the percentage of sandwiches, 1.46, although not significant, was practically twice that of the other carbohydrate foods, .74 per cent. The refusals of desserts were listed according to the different kinds of dessert, but here again the total number of refusals was so small, 116, that it did not offer enough difference for comparison.

The total percentage of records of "disliked but ate" was 3.25. Since the correlation between the number of urgings and the percent of records "disliked but ate" was .70 ±.06 it might be inferred that the records of "disliked but ate" showed the influence of the student in charge. Of the total number of times milk was offered, 3005, there were only 36 times that the children "disliked but ate," a percentage of 1.19.

TABLE 8

Record of foods refused or disliked but eaten

FOOD	TIMES OFFERED	REFUSED		DISLIKED BUT ATE	
		Times	Per cent	Times	Per cent
Milk	3,005	22	.73	36	1.19
Other proteins:					
Eggs	875	15	1.71	33	3.77
Salmon	385	5	1.3	15	3.9
Meat	905	8	.88	11	1.21
Cottage Cheese	171	9	5.26	16	9.35
Total	2,336	37	1.62	59	2.56
Vegetables	3,005	47	1.56	161	5.35
Carbohydrates:					
Potatotes, Rice or Spaghetti	2,947	30	.74	101	2.88
Sandwiches	3,005	44	1.46	89	2.96
Total	5,952	74	1.24	190	3.19

An examination of the records of the protein foods other than milk in the category "disliked but ate" shows some interesting comparison, although the records are so few that the comparisons are not significant. The percentage of "disliked but ate" for cottage cheese is 9.35, or more than twice as much as the percentage for eggs, 3.77, or fish, 3.9, which are practically the same. Meat shows much the lowest percentage, 1.21, or one-third that for eggs and fish. The number of records of vegetables "disliked but ate," 161, is divided rather generally among the individual vegetables, and these records are also too few to be significant for comparison. The percentage of times "disliked but ate," 5.35, is somewhat higher than that for other foods, however, and lends a little weight to the impression that vegetables are not liked as well as other foods. The common impression that children like carbohydrate foods is borne out by the records, which show that there are only 190 cases of "disliked but ate," or a percentage of 3.19. The 63 records of desserts "disliked but ate" are pretty generally divided among the various desserts. The percentage of times "disliked but ate" is very low, 2.09.

In general there is little difference in the refusals of vegetables, carbohydrate foods, and protein foods other than milk; the refusals of milk are somewhat lower than of these foods; and of desserts a little more than twice as high. In all cases, however, the percentages are too low to be very significant. There is more variation in the percentage of records of "disliked but ate," the percentage for vegetables being enough higher than the others to indicate more of a dislike for these foods than for the others. Nevertheless, the total records of "disliked but ate," 3.25 per cent, is too low to have much weight.

Length of nursery school attendance apparently had some influence on the various attitudes which the children assumed toward their food. The correlation coefficient for length of nursery school attendance and "with relish" (.39 ±.09) indicates that to a certain extent the longer the child has been in the nursery school the more likely he is to eat with relish. (See table 4.) Age seems to be something of a factor here, for when it is held constant the coefficient drops to .27. According to the coefficient for length of nursery school attendance and "as a matter of course," −.31 ±.10, the child tends to eat less as a matter of course the longer he has been in the nursery school. Age appears to enter here, too, for when partialled out the coefficient becomes −.16. There is little relationship between the length of nursery school attendance and "disliked but ate," according to the coefficient −.22 ±.11. Age apparently does not enter in, because the coefficient for "disliked but ate" and age is .02 ±.11. The coefficient for nursery school attendance and "refused" is −.31 ±.10, the same as for "matter of course," and with age held constant becomes −.16.

These results are consistent with one another but do not indicate as high a degree of relationship as one might expect. They do indicate that, atleast in a small measure, the children's attitude toward their food improves with attendance at the nursery school. It is possible that greater improvement might have been shown if the records had been available for the earlier months of the school year.

Since on the average 94.8 per cent of the records on the attitude of the children toward their food indicate that the children ate their food because they liked it, and a study of the records of refusals and "disliked but ate" shows relatively little difference in liking for the different foods, it seems fair to assume that the chief factor in the kinds of food eaten by these children is the fact that they liked it. This evidence of liking the various foods is so marked in contrast to the idiosyncrasies reported in the home—Roberts and Moseley (23), Barker (5), Blanton and Blanton (6), W. R. P. Emerson (13), Gruenberg (18), Imlay (19), Mohr (21), Rice (22), Schmidt (27), Sholley (28), and Anderson and Foster (2)—that one is forced to the conclusion that the nursery school situation is responsible. Miss Lydia Roberts, University of Chicago, one of the foremost students of child nutrition today, voices a similar conclusion when she says, "Perhaps the most effective agency now existing for improving child nutrition is the nursery school" (23).

SUMMARY

1. Records of the food and eating habits of the nursery school children at the institute of Child Welfare, the University of Minnesota were studied statistically to determine some of the factors affecting the amount and kind of food eaten by these children. There were 3005 records made on 37 children by 46 students over a period of 7 months and 10 days.

2. There is no sex difference in the amount of food eaten by these children. A significant age difference is evident only between the youngest group of children, ages 1:6—2:5, and the oldest group, 3:5—4:8, the D.S.E. of D being 4.17.

3. The children who stay at the table the longest time on the average tend to eat less food, as indicated by the coefficient of correlation, –.65 ±.06. Even when age is held constant this relationship is maintained, although to a somewhat less degree, (r is –.55).

4. The influence of the students in charge of the children when at their tables at lunch time was shown by the students' standard deviation scores. With some students the children ate more than their average, with some cases less, and sometimes there was no difference.

5. The correlation between the amount of food eaten and the length of nursery school attendance is positive, but the coefficient is not very high—.40 ±.09. Moreover, when age is held constant the coefficient becomes .017, so that age seemed to be the chief factor.

6. Four different attitudes of the children toward their food were reported: "with relish," 68 per cent of the time; "as a matter of course," 26.8 per cent of the time; "disliked but ate," 3.25 per cent of the time; and "refused,' 2.23 per cent of the time. The scores on these attitudes were correlated with the mean number of calories eaten daily. The correlation with "with relish" was .68 ±.06; with "matter of course," –57 ±.07; with "disliked but ate," –.39 ±.10; and with refusals, –.62 ±.07. All these relationships are in accord with expectation.

7. The number of urgings and the amount of food eaten (–.53 ±.08), and the number of times help was given and the amount of food eaten (–.44 ±.09), point out the inverse relationship that would be anticipated.

8. There is no significant difference in the mean amount of calories eaten by these children in the winter and in the summer months, as determined by

D.S.E. of D. These findings are interesting in the light of Clayton's (9), who finds no seasonal variation in growth.

9. The relationship between bodily activity during the meal and the amout of food eaten is very low—.11±.11. With age constant it becomes negligible—.057.

10. The conversation at the table other part of the child and the amount of food he eats apparently have little in common. The coefficient of correlation is .37 ±.09, and with age partialled out it becomes .016.

11. There is little relationship between the amount of food the children eat and their attitude toward one another, according to the correlation, .12 ±.11.

12. That the attitude toward the student at the table did not have a very marked influence on the amount of food the children ate is evident from the correlation of 23 ±.10 between it and the mean amount of food eaten.

13. The coefficient of correlation between the amount of food eaten and the children's attitude toward visitors is .20 ±.11, which indicates that these children are less disturbed by visitors than one might think. Age appears to enter in, for when it is held constant the coefficient becomes −.03.

14. Six training methods were used; praise, favorable comparison, critical comment, timing, reward, and example. Surprisingly enough, the coefficients of correlation show very low relationships in case of praise, favorable comparison and reward, and low negative relationships with timing and example.

15. A table was prepared showing the influence of the various factors above in the case of the ten children who ate the highest average amount of food and the ten who ate the lowest average amount of calories. The results on this table checked with the correlations.

16. An analysis of the refusals of food, which were recorded as the attitude toward food only 2.23 per cent of the time, showed very little discrimination between vegetables, carbohydrates and protein food other than milk. The refusals of milk were the least frequent, and those of desserts the most often.

17. The attitude of "disliked but ate" was assumed most often toward vegetables and least often toward milk, the other foods ranging in between. This result gives some support to the opinion that children like vegetables the least of any food.

18. Correlations between the length of nursery school attendance and the attitudes toward food show a slight tendence on the part of the children to eat more "with relish," less as a matter of course, to assume the attitude of "disliked but ate" less, and to make fewer refusals of food the longer they are in the nursery school.

19. Since on the average in 95.8 per cent of the time the children are reported as liking their food, it seems safe to assume that this is the important factor in the kind of food eaten.

The nursery school environment where only those children who are, normal physically are permitted, where the meal is carefully balanced; the children's health is safeguarded, the equipment is suited to the child's size and needs, a fixed routine is maintained, causes for emotional disturbance are reduced to the minimum, not too much but enough attention is given, and a happy, comradely atmosphere is maintained, may justly be assumed to have a large part in this wide-spread liking of food.

REFERENCES

(1) Aldrich, C. A.: Prevention of poor appetite in children. Mental Hygiene, 1926, **10**, 701–711.

(2) Anderson and Foster: The young child and his parents. Minneapolis, The University of Minnesota Press.

(3) Baker, S. J.: The growing child. Boston, Little Brown and Company, 107.

(4) Baldwin and Stecher: Psychology of the pre-school child. New York, D. Appleton and Company, 240–43.

(5) Barker, M. E.: A study of the group lunch as a means of solving some problems in feeding the pre-school child. Master's thesis, University of Chicago, August 1924.

(6) Blanton and Blanton: Child guidance. New York, The Century Company, Chapter III.

(7) Ibid: Chapter IX.

(8) Cameron, H. C.: The nervous child. London, Oxford Medical Publishers, 68.

(9) Clayton, B. C.: A study of the diet of the pre-school child in relation to seasonal variation in growth. Master's thesis, University of Minnesota, 1927.

(10) Cleveland, E.: Training the toddler. Philadelphia, Lippincott, 1925, 37–44.

(11) Cowgill, G. R.: A relation between appetite and the energy factor in nutrition: A practical consideration. Journal of Biol. Chem., 1926, **67**, 53–54.

(12) Editorial: Child development at the University of Nebraska. Jour. Home Economics, 1927, 427–429.

(13) Emerson, W. R. P.: Nutrition and growth in children. New York, D. Appleton and Company, p. 151.

(14) Forest, Ilse: Pre-school education. New York, The Macmillan Company, 1927, Chapter 8.

(15) Foster, Orline: The nursery school as a child builder. Mother and Child, January 1923, **4**, 3–8.

(16) Garrett, H. E.: Statistics in psychology and education. New York, Longmans, Green and Co., 1926, 128–133.

(17) Ibid: 221–231.

(18) Gruenberg, S. M.: Health training of the pre-school child. Kindergarten and first grade, March 1926, **11**, 9–10.

(19) Imlay, F.: A study of the food consumption and food habits of young children and the extent to which they may be modified by the nursery lunch. Master's thesis, University of Chicago, 1925.

(20) Johnson, Harriet M.: Nursery school experiment. New York, Bureau of Education Experiments, 144 West 131st St., 1924, p. 31.

(21) Mohr, G. J.: Emotional factors in nutrition work with children. Mental Hygiene, 1928, **12**, 360–377.

(22) Rice, C. H. Jr.: Some feeding problems of childhood. Scientific Monthly, April 1925, **20**, 379–382.

(23) Roberts, L. J.: Nutrition work with children. Chicago, University of Chicago Press, 1927, Chapter 8.

(24) Roberts, L. J.: The prevalence of non-hunger among children and some of its contributing factors. Parent Education, Minneapolis, University of Minnesota Press, 54–72.

(25) Roberts, L. J.: Teaching children to like wholesome foods. Am. Jour. Pub. Health, January 1925, **15**, 52–53.

(26) Rose, M. S.: The foundations of nutrition. New York, The Macmillan Company, 1927, 399–405.

(27) Schmidt, C. R.: Psychology of child nutrition. Jour. Home Economics, May 1925, -7, 260–264.

(28) SHOLLEY, R.: Nutritional and management problems in the pre-school clinics of the infant welfare of Minneapolis. Master's thesis, University of Chicago, 1925.

(29) SWEENEY, M. E.: Some observations on the feeding of young children. Jour. Home Economics, June 1927, 19, 307–312.

(30) SWEENEY, M. E.: Teaching the little child health habits. American Childhood, April 1928. 13, 9–11.

(31) THOM, D. A.: Everyday problems of the everyday child. New York, D. Appleton and Company, Chapter 4.

(32) WHITE, E. N.: Objectives of the American nursery school. Family, April 1928, 9, 50–51.

A Study of Five Bilingual Children from the Same Family

Madorah E. Smith

THE five children discussed in this study are a boy and four girls from the same family who lived part of their lives in China, where the four girls were born, and part in the United States, the country of their parents.

During their residence in China, they were exposed to two languages in their own home; English from their parents and Chinese from the servants. Their contacts with other children outside their home were mainly with other bilingual children of American or Canadian parentage, although there was a little contact with non-English speaking Chinese children. These bilingual children ordinarily used English as their medium of conversation. The formal education of the three older children who lived long enough in China for their schooling to be begun there was almost entirely in English. It is probably near the truth to estimate that their exposure to English and Chinese while in China was approximately equal until after three years of age when with increasing contact with other English-speaking children and the beginning of their formal education a few years later, English became more and more their preferred language. During their residence in the United States, however, practically no use was made of Chinese by either the children or their parents except for a few handy phrases.

One child, Ruth, was really monolingual until almost three years old as she spent the period from fourteen to thirty-four months in America. She thus serves to some extent as a control for the three children who were bilingual at that age.

The mother's records of the vocabularies of the four older children at twenty-one and twenty-four months as given in the table show that Ruth, the monoglot, used over twenty per cent more words at each age than did her brother, although, his mental ability as measured on the Stanford-Binet test at a later age was greater than hers. Ruth's vocabulary also was twice as large at twenty-one months and fifty per cent larger at two years than that of her older sister whose I.Q. is the same at a time when the two girls were equally bilingual. Lois, whose I.Q. exceeds Ruth's by ten points at nine years, however, equals her sister in size of vocabulary at two years. The distribution of these vocabularies between English and Chinese words are given in the table.

Jane, John and Lois were all exposed to the two languages during their second year. John, although born in the United States spent the period from eleven months until seven-and-a-half years in China. Jane and Lois lived in China from birth until thirty-two and thirty-seven months old respectively and Jane returned to China, living there again from four years to ten-and-a-half years. John, owing to his mother's illness was cared for more by the Chinese nurse than were any of his sisters. This, probably, accounts for the higher percentage of Chinese words in his vocabulary.

During Jane's visit to the United States from thirty-two months to four years, she forgot much of her Chinese through disuse, though not so much as did Lois in the same length of time; owing to whooping cough and her mother's health (it will be remembered that her brother was born during this visit to America), Jane was confined pretty closely to home where her Chinese was understood; while Lois was sent to nursery school. That Jane's Chinese was not entirely forgotten is indicated in the Stanford-Binet test given her at three years eleven months when in response to the question, "What is a horse?" she answered, "Namo *ma*," (the Chinese word for horse).

Lois had made a good start in talking before she left China just before her third birthday. Her vocabulary at two years was almost the same size as that of her monolingual sister and she seldom confused the two languages. But when she was enrolled in the Iowa Child Welfare Research Station's Preschool Laboratory at three years and three months, her mental age was only two years ten months and her vocabulary score was 960 words by the Smith Vocabulary Test. This was about four months below the norm for her age, when she was given that test at thirty-eight months. At three years five months, her vocabulary had increased to 1100 words which was equivalent to only about two months below her age level. And in the spring, at three years eleven months when her second language was completely forgotten, her mental age was four years giving her an I.Q. of 102 as compared with that of 87 in the fall. Five years later at nine years one month, in spite of a year of serious illness intervening which was due to complications from scarlet fever, Lois's I.Q. had continued to increase and was then 112.

Three of the four older children were tested at two or three years of age and again at nine or ten years. In every case the test used was the Stanford-Binet and a gain occurred in I. Q. In the case of Ruth, who on neither occasion was much affected by her knowledge of Chinese, the gain in I. Q. was but five points. Jane, who was still using a very little Chinese at the time of the first test and used English much oftener at the time of the second test, gained eight points. By the time of their second tests, these two girls, although able to use Chinese to a considerable extent, showed much greater facility with English and used it preferably whenever it would be understood. Lois, however, was still bilingual at the time of her first test, although she, too, was beginning to lose her former facility, and when she was nine years old she had completely forgotten her Chinese. She gained twenty-five points in I. Q. Apparently, the more truly bilingual the child was at the earlier age, the more her I.Q. was affected.

The baby Mary had begun to talk and used quite a number of words, both Chinese and English (unfortunately the exact number is not available) at the time the family left China when she was fifteen months old. By twenty-one months, all but one Chinese word had been dropped from her vocabulary and moreover, she was talking less and her English vocabulary had not increased by more than one or two words. At two years five months, she was still backward in talking, a sample of her conversation recorded at that time gave her a sentence length of but 1.7 words per sentence, which is the average for two year olds, showing a retardation of five months at that time although her I.Q. of 114 at seven years would indicate a superior intelligence. This later retardation is due in part, however, to a mastoid operation at twenty-three months. The case of another child, similar to Mary's, has come to the writer's attention. Avis Ann, at nineteen months was

TABLE 1

Size of vocabulary and mental test scores of the five children

	JANE	RUTH	JOHN	LOIS	MARY
Birth order	1	2	3	4	5
Vocabulary at					
21 months (Norm 118 words)					
English words	45	121	41		19
Chinese words	16	3	61		1
Total	61	124	102		20
24 months (Norm 272 words)					
English words	122	250	83	164	
Chinese words	42	0	118	91	
Total	164	250	201	255	
Early mental test					
C. A. (years and months)	3–11	2–7		3–3	
M. A. (years and months)	3–8	2–6		2–10	
I.Q.	93	97		87	
Later mental test					
C. A. (years and months)	10–10	9–6	7-8	9–1	7-4
M. A. (years and months)	10–11	9–8	8-8	10–2	8-4
I.Q.	101	102	113	112	114
Gain in I.Q. of those tested twice	8	5		25	
Age of residence in China					
From	Birth	Birth	11 mos.	Birth	Birth
To	32 mos.	14 mos.	7 yrs. 5 mos.	35 mos.	15 mos.
And second residence					
From	4 years	34 mos.			
To	10 yrs. 7 mos.	9 yrs. 3 mos.			

brought from a bilingual environment in China to Honolulu where the Chinese she had learned was not understood. She, too, ceased her progress in speech and even went backward for a time.

CONCLUSIONS

The cases of the two babies who were just beginning to talk at the time of change to an environment where a language they had used was not understood suggest that such a change causes enough mental confusion to a child, when he finds words that have heretofore produced results no longer do so, to cause him to tend to cease further attempts at speech for a time.

Lois's case of relatively low I.Q. and vocabulary at the time when she was adjusting to a similar change in environment with the later rise in both vocabulary and I.Q. as she forgot one of the two languages she spoke suggests that confusion arises from the use of two languages in preschool years.

The larger size of the vocabularies of the monolingual child, especially when the I.Q.'s of the children are taken into consideration, would also suggest a confusion in learning to talk on the part of the bilingual children. For norms referred to in this study see Madorah E. Smith (1).

REFERENCES

(1) SMITH, MADORAH E.: An investigation of the development of the sentence and the extent of vocabulary in young children. Univ. of Iowa Studies in Child Welfare, 1926, III, no. 5.

The Effect of Surroundings on Free Association in Young Children*

HELEN M. SUNDBERG

THE purpose of this study was to determine the effect of surroundings on free association responses made by young children. Much work has been done in the field of free association, but there is practically no experimental evidence concerning the effect of the immediate environment on results of such tests. The problem is an important one in the psychological field, especially in the experimental and testing divisions. Because of the emphasis placed on experiments of this nature in child welfare and child psychology, this study should be of value in further experimentation of this type.

The only experimental work which has much relationship with this study is that which has been done in connection with the naming sixty words test which is found in several of the standard individual intelligence scales. This test is located at ten years in the Stanford-Binet, and at eleven years in the Goddard and Kuhlmann tests. In his general procedure for giving this test, Terman uses the following instructions:

> "Now, I want to see how many different words you can name in three minutes. When I say 'ready,' you must begin and name the words as fast as you can, and I will count them. Do you understand? Be sure to do your very best, and remember that just any words will do, like 'clouds,' 'day,' 'chair,' 'happy,'—Ready, go ahead." If there is a pause of more than fifteen seconds within the test, the child is urged with, "Go ahead, as fast as you can. Any words will do."

The test is passed if sixty words are named in three minutes. For the 10 year olds, Terman found the average number of words for the six successive half minutes to be: 18, 12½, 10½, 9, 8½, 7. He found that usually only the very intelligent improve after the first half minute. He also found that a large number of repetitions indicates a tendency to mental stereotypy. He states that the proportion of repetitions made by normal children rarely exceeds 2 or 3 per cent of the total number of words while retarded children of the same level often reach 6 or 8 per cent. There was a slight superiority of girls over boys shown throughout the entire scale from 5 to 13 years.

Terman (2, 3) found also that the per cent passing below I.Q. 96 was 30; those passing between I.Q. 96 and 105 were 70; while the per cent passing above I.Q. 105 was 76. In discussing the types of response in relation to the testing room he writes,

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* The writer gratefully acknowleges the advice and encouragement given her in the preparation of this study by Dr. Florence L. Goodenough.

> "Another type of response consists in naming only objects present, or words which present objects immediately suggest. It is unfortunate that this occurs, since rooms in which testing is done vary so much with respect to furnishings. The subject who chooses this method is obviously handicapped if the room is relatively bare. One way to avoid this influence is to have all subjects name the words with eyes closed, but the distraction thus caused is sometimes rather disturbing. It is perhaps best for the present to adhere to the original procedure and to follow the rule of making tests in a room containing few furnishings in addition to the necessary table and chairs."

METHOD

Subjects

The subjects of this experiment were children attending the nursery school and kindergarten of the University of Minnesota Institute of Child Welfare. Records were obtained for 60 children, 30 boys and 30 girls, ranging in age from 2½ years through 5 years. Only three of the children were below 3 years at the time of their tests and in two of the cases this was only a matter of two and three months.

Experimental procedure

The best method of testing the effect of the surroundings on the responses of the children seemed to be to subject them at one experimental period to an environment containing a large number of external stimuli and at another time to place them in surroundings as free as possible from such stimuli. This was done by testing the subjects at one time in a room bare of all unnecessary objects and then repeating the experiments in the same room containing a great number of articles. The room used was a rather small one, 11½ feet by 7 feet, lighted by a sky light in a sloping roof. The children could see only sky from the skylight, and so no outside visual distraction was present. A radiator below the skylight, a tier of shelves in one corner, an electric light, and two doors were also unremovable parts of the room. These, with the two chairs used by the experimenter and the subject and the recording apparatus, consisting of record blanks, pencil or pen, and stop watch, were necessarily present at all periods. The additional objects placed in the room at the crowded sittings were: a wagon, kiddie car, truck, small iron fire engine, wheel barrow holding a large wooden ball, folded cot, box with blanket on it, large basket holding some blocks, small hobby horse, large chair, and several books placed on one of the shelves.

The children were divided into two groups, each one paired with another according to sex, age, intelligence (I.Q.), and occupational status of the parents. In order to avoid the error that practise effect would have on the results, one group of the children was started in the empty room, while the other group was first tested in the crowded room.

Each experimental period was two minutes in length rather than the three minutes used by Terman. The three minute period seemed rather long for such young subjects and avoidance of fatigue was important. The responses were taken down sepa-

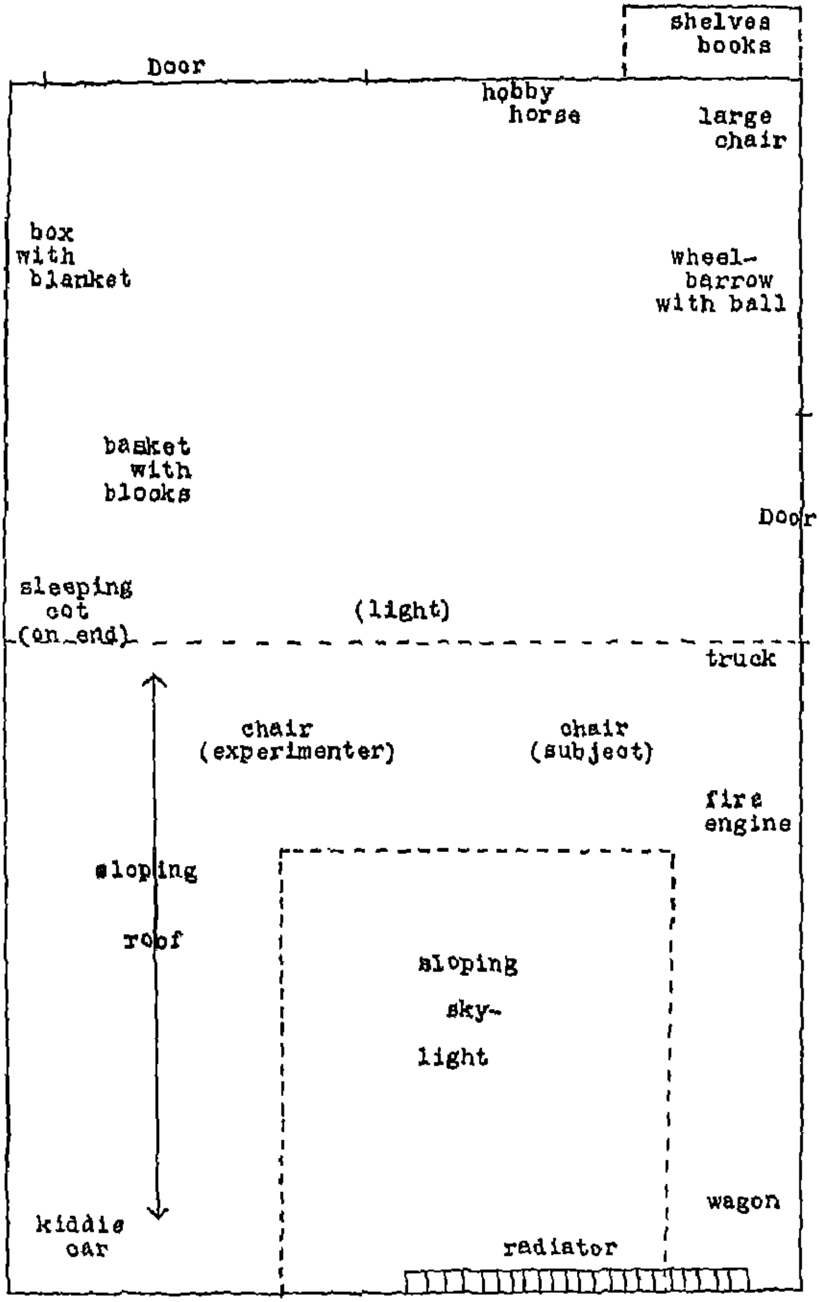


FIG. 1. SITUATION OF OBJECTS IN CROWDED ROOM

rately for each ½ minute and each subject was tested at four different periods within two weeks. Four succeeding days were used if this were possible but often absences or other experiments interferred. However, the cases were discarded where experimentation covered a longer period than two weeks. The children in group one were tested in the empty room for the first experimental period, in the crowded room for the second, then in the empty room once more, and finally were placed in the crowded situation again. For those in group two the same method was used except that their first experimental period was in the crowded room and their last in the empty one.

The name and the group number of each child was placed on each record blank, and the date, time at which the test was given, and the condition of the room (empty or crowded) was recorded for each of the four experimental periods. All of the responses of the subjects were taken down with the responses for each half minute divided into separate sections.

As each child came into the room a few moments were taken for conversation in which an attempt was made to establish "rapport" with the subject and to make him feel at ease. This was difficult in only a few cases as the experimenter was an assistant in the nursery school and was known to all of the younger children. The cases in which the child refused to respond were eliminated. The experimenter then said, "Tell me all of the things that you can think of. You can think of a door, can't you? You can think of a dog, and a light, and the sky, can't you? Now, can you tell me all the other things you can think of?" During the period in the crowded room the words wagon, grass, truck, and tree, were substituted for those used above. In both instances two of the objects named were in the room and two were outside associations.

At the first response the stop watch was started. If the child made no response, he was urged again, "You can think of many more things, can't you? Tell me all the other things you can think of." This urging was also used for pauses of longer than ten or fifteen seconds. If the child began repeating only the examples used by the experimenter, the latter said, "You can think of many other things too, can't you? Tell me all the other things you can think of."

At the end of each experimental period each child was given a small star which was pasted onto a small oblong piece of paper. This was in no sense a reward for good behavior as every subject was given one as a part of the general procedure and no mention was made of what had gone before. The intention was to keep up the children's interest throughout the four periods. This proved on the whole, very successful as the children were very proud of their stars and wished to keep repeating the experiment. A blue star was given at the end of the first experimental period, a red one at the end of the second, a silver one at the end of the third, and a gold one at the end of the fourth period.

No child was given the test more than once on one day. Most of the children were tested during the hours from 9:30 to 11:00 in the morning. The exceptions to this were the children of the afternoon kindergarten session who were tested from 1:30 to 2:30. These hours appeared to be the best for the experimental work as at those times the children are usually feeling at their best.

RESULTS

Treatment of data

The words given by each of the subjects during the four experimental periods (I-E, II-E, I-C, and II-C were totaled both for the half minutes and for the entire two minutes. The lists were then looked over and the responses totaled excluding all repetitions. Then the number of words of outside associations were recorded both with and without repetitions. From the list of outside associations all words which were specifically connected with the experimental situation or procedure were omitted. Thus none of the words which had been used as examples by the experimenter were counted. Likewise such things named as articles of clothing worn by the experimenter or subject were excluded.

TABLE 1

Age distribution of subjects

	3 YEARS	4 YEARS	5 YEARS	WHOLE GROUP
Girls	6	8	16	30
Boys	5	9	16	30
Total	11	17	32	60
Mean age in months	37.45	52.53	64.87	50.32

The totals under all these conditions were then averaged so that the mean score (number of words) might be obtained for the four experimental periods. This same procedure was followed for each of the half minute periods also. The sixty subjects were then divided into three groups according to age, 3 year olds, 4 year olds, and 5 year olds. The three children who lacked a few months of being three years were included with this group. The 3 year olds consisted of the children ranging in age from 2 years, 10 months to 3 years, 10 months; the 4 year olds ranged from 3 years, 10 months to 4 years, 10 months; and the 5 year olds covered from 4 years, 10 months to 5 years, 10 months.

TABLE 2

Reliability coefficients

CORRELATIONS BETWEEN:	r	P.E.	r RAISED BY SPEARMAN-BROWN FORMULA
I-E and II-E, all words included	.59	.050	.74
I-C and II-C, all words included	.78	.0341	.88
I-E and II-E, repetitions excluded	.68	.0468	.81
I-C and II-C, repetitions excluded	.75	.038	.86

Table 1 shows the distribution of subjects according to age and sex and the mean age of the whole group and for each age group.

The half minute totals for these age groups were then recorded and averaged. Groups averages for the second, third, and fourth half minutes were expressed as percentages of the first half minute for the four experimental periods.

Reliability

The totaled scores for all the children for I–E (first experimental period in empty room) were then correlated with the total scores of II–E, and the same was done for the I–C scores (first time in crowded room) and the II–C scores (second time in crowded room). Correlations were also figured for I–E and II–E without repetitions, and I–C and II–C without repetitions. The results are shown in table 2.

TABLE 3

Average number of associations

	I–E		II–E		I–C		II–C	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Total words	17.68	8.54	22.27	8.44	20.30	8.28	24.20	9.38
Without repetitions	15.98	7.94	21.05	7.64	19.75	7.81	20.07	8.46
Total outside associations	9.0		11.17		6.45		8.25	
Without repetitions	8.57		10.18		6.1		7.53	

The correlations between the crowded situations, both with and without repetitions, are a good bit higher than those between the empty situations. This is especially interesting considering that Terman advises as bare a room as possible for the sixty word test. Another interesting point is that in the case of the empty room the correlation is raised by excluding repetitions whereas in the crowded situation it is lowered by 3 points by this exclusion. It might have been expected that the correlations between scores with repetitions excluded would be higher in both cases. The fact that the differences are reversed between these two sets of correlations may be due to chance.

The reliability of the difference between the coefficients for the empty and crowded situations were determined. The results obtained with and without repetitions were .066 and .06 respectively. When the obtained differences between the two correlations were divided by the probable error of the difference, in both instances the results were 2.88 when all words were used and 1.17 when repetitions were excluded. Therefore, when all words are included, there were 97.5 chances in 100 that the true difference in favor of the crowded room is greater than zero; when repetitions are excluded, there are only 78.4 chances in 100 that the difference favoring the crowded room is greater than zero.

In correlating the combined scores for the empty situation with the combined scores for the crowded situation the results obtained were:

	r	P.E.
E and C with all words included	.63	.0525
E and C without repetitions	.89	.0180

The first correlation .63 is rather low but when repetitions are excluded the higher r of .89 is obtained. This indicates that the individual children tend to hold their place much better in the two situations when repetitions are excluded.

General averages

Table 3 shows the average number of words for the whole group of sixty children for the four experimental periods.

As will be noted in a comparison of the averages of all words and the averages without repetitions, the second crowded period is the only one in which more than two words are repeated. In this there were 3.23 repetitions. This is an interestng point, for, considering the youth of the subjects, more repetitions might have been expected. In the averages of outside associations the mean number of repeated words is never greater than one.

TABLE 4

Per cent of repetitions

	I-E	II-E	I-C	II-C
	per cent	*per cent*	*per cent*	*per cent*
Total words..............	8.4	5.4	2.7	13.3
Outside associations.....	4.8	8.8	5.4	8.7

The proportion of repetitions to total number of words as shown by per cents is greater in most cases than that given by Terman for normal children. He found 2 or 3 per cent repeated words in normal children while 6 or 8 per cent were given by retarded children. Table 4 shows the per cents found in this study. The higher per cents seem natural since the subjects were so much younger than those used by Terman.

On the average the fewest number of words were given in the first empty period and the greatest number in the second crowded situation. More words were given in the second empty situation, however, than were given in the first crowded situation. In the averages excluding repetitions the second crowded period loses its lead to the second empty period. This, however is not significant as the difference is only .08 of a word. Fewer outside associations were given in the crowded room than in the empty one. In both instances in the crowded room, with and without repetitions, the mean number of outside associations was less than in the first empty period. The greatest number of outside associations were given in the second empty period. It is natural that there were more outside associations in the empty room because the child had fewer inside stimuli on which to draw.

TABLE 5

Scores by half minute intervals

		FOUR SUCCESSIVE HALF MINUTES			
		1	2	3	4
Whole group averages	I-E	6.13	4.03	3.56	3.95
	II-E	7.25	5.42	4.78	4.08
	I-C	6.68	5.05	4.22	4.35
	II-C	8.53	5.77	5.07	4.50

The results for the four successive half minutes of the four experimental periods can be seen in table 5, and a comparison with the results found by Terman for his 10 year olds is given in table 6.

The average number of words given by Terman's subjects is, naturally, greater than the average found in this study. The per cents, however, do not differ radically, especially for the second and third half minutes and in the fourth half minute the children of this study hold up somewhat better than did Terman's. Terman finds a decrease in per cent for each successive half minute. On the whole the same tendency is found in this study. However, a few exceptions may be noted here. An increase in the average number of words is found in the last half minute in two cases out of four (I–E and I–C) and the whole group (table 5); in three cases out of four (I–E, I–C, and II–C) for the five year olds (table 7); and in three cases out of four (I–E, II–E, and I–C) for the four year olds. In the three year old group there is a decrease in the last half minute in all cases except I–C where the average number of words is the same as in the third half minute. In I–E and II–E, however, the average of the third half minute is larger than that of the second half minute.

TABLE 6

Comparison with Terman's results

		SUCCESSIVE HALF MINUTE					
		1	2	3	4	5	6
		Average number of words for Terman's 10 year olds					
		18	12½	10½	9	8	7
Per cent of first half minute	Terman's	100	69.4	58.3	50	47.2	38.9
	I–E	100	66	58	64		
	I–C	100	70	63	65		

Correlation with I.Q.

The scores for the crowded room and those for the empty room were correlated with the I.Q.'s received by the children when tested with the Minnesota Intelligence Test. The results were as follows:

	r	P.E.
C scores and I.Q.	.14	.087
E scores and I.Q.	.10	.088

These correlations are so low that they probably come within the limits of chance. As will be noted the probable errors are very large.

Sex differences

In comparing the mean number of words given by the thirty boys and the thirty girls in the four different periods for all words, with and without repetitions, and for outside associations with and without repetitions, the boys averaged fewer words in 8 of the cases, were even with the girls in 4, and averaged slightly higher in all of the results obtained in the II–E period. Table 8 shows these results. Most of the differences shown in the table are very small and probably insignificant. The largest is found in II–C for all words where the girls average 3.76 words more than the boys. This is evened up, however, when repetitions are excluded. To draw conclusions from data with so few cases is hazardous, but the results are at least suggestive and may mean that the girls are more talkative at the outset but that the boys have more associations and get larger scores in the second experimental periods when their inhibitions are reduced.

Occupational status

The nursery school and kindergarten children are placed in groups from I to V according to the occupation of the father. There are no cases in group VI, which consists of unskilled laborers. Members of group I are professional people and the others range down to the laborers. For purposes of comparison, the children in this study were placed in two groups, the first including the subjects who belonged in groups I and II, and the second those who belonged in groups III, IV, and V. In all cases the mean number of words given by those in III, IV, and V was less than the average number for those in I and II, either with or without repetitions. The greatest difference was a superiority of

TABLE 7

Scores by half minute intervals and by age

		FOUR SUCCESSIVE HALF MINUTES			
		1	2	3	4
5 year olds averages	I-E	7.31	5.06	4.41	5.19
	II-E	8.44	6.75	5.66	5.59
	I-C	7.91	5.91	5.25	5.38
	II-C	10.09	6.66	6.06	6.53
4 year olds averages	I-E	5.82	3.76	3.18	3.41
	II-E	6.59	4.71	4.35	4.59
	I-C	6.35	4.65	3.24	3.47
	II-C	7.76	6.00	5.12	4.12
3 year olds averages	I-E	3.18	1.45	1.73	1.09
	II-E	4.82	2.64	2.91	2.18
	I-C	3.64	3.18	2.73	2.73
	II-C	5.18	2.82	2.09	1.91

TABLE 8

Averages according to sex

		I-E	II-E	I-C	II-C
Averages of total words	Girls	18.69	22.72	21.24	25.21
	Boys	17.90	23.34	20.76	21.45
Average without repetitions	Girls	18.10	20.24	20.10	22.66
	Boys	10.59	21.55	19.38	22.76
Outside associations	Girls	9.69	10.45	6.06	8.48
	Boys	8.97	12.62	6.72	8.55
Outside associations without repetitions	Girls	9.38	9.48	6.45	7.69
	Boys	8.38	11.59	6.17	7.86

2.47 words for those in I and II in the II–C situation. When repetitions were excluded this became 3.43 words. In the I–C situation when only outside associations were counted, the lower group had a slightly higher score. In the other averages of outside associations with and without repetitions, those in groups I and II had a higher average. The occupational class differences may be seen in table 9. Although these differences are small, the fact that they are found in all of the conditions is significant.

TABLE 9

Averages according to occupational class

	OCCUPATIONAL CLASS	I–E	II–E	I–C	II–C
Averages of total words	I and II	18.56	23.07	20.78	25.56
	III, IV and V	17.00	22.22	19.91	23.00
Average without repetitions	I and II	17.81	20.67	19.85	23.85
	III, IV and V	15.88	19.70	18.48	20.42
Outside associations	I and II	9.93	12.03	6.11	8.56
	III, IV and V	8.24	10.42	6.70	8.00
Outside associations without repetitions	I and II	9.59	11.37	5.85	8.11
	III, IV and V	7.73	9.21	6.30	7.06

Correlations with other traits

Twenty-nine of the subjects of this experiment had been members of the nursery school the preceding fall when an observational study was made on a number of traits. A description of the method used in this study will be found in an article by Florence L. Goodenough (1). Data taken from this experiment made possible correlations between the combined scores for both the empty and crowded room and results found in the study of talkativeness, nursery school attendance, Marston ratings for extroversion and introversion, and chronological age. These correlations are shown in table 10.

The correlations for both the crowded and empty averages and the Marston ratings are so low that they come within the limits of chance. This is also true of the correlations with the talkativeness scores. At any rate

TABLE 10

Interrelations between E and C scores an other traits

	r	P.E.
E scores and Marston scores.	.14	.1230
C scores and Marston scores.	.00	.1250
E scores and talkativeness...	−.04	.1254
C scores and talkativeness...	.22	.1104
E scores and C. A............	.60	.0803
C scores and C. A............	.78	.0491
E scores and N. S. attendance.	.04	.0740
C scores and N. S. attendance.	.42	.1033
N. S. attendance and C. A...	.80	.0452
E scores and N. S. attendance (C. A. partialled out).....	.33	.1097
C scores and N. S. attendance (C. A. partialled out)......	−.54	.0870

the probable errors are too large to make the correlations reliable.

The correlations with C.A. show, as would be expected, a positive relationship and indicate that the older children give more words, on the average, than the younger children. A correlation of .60 with the scores for the empty room and of .78 for the crowded averages indicates a tendency for the older children to name more words in the C situation than in the E room. The older children perhaps pay more attention to the articles about them than the younger ones. The total scores for the empty and the total scores for the crowded situation show correlations with nursery school attendance of .64 and .42 respectively. When C.A. is partialled out the correlations become .33 and −.54 respectively. This might indicate that the children who have attended the nursery school longest have a tendency to make less use of observation of articles in the crowded situation. However, since the cases are few, the probable errors are high; and so, on the whole, these correlations do not have great significance.

SUMMARY

Free association tests given to preschool children in an empty and a crowded room gave results as follows:

1. Higher reliability coefficients were obtained for tests given in the crowded room; in other words the crowded situation had a more constant effect on the scores made by these children, an interesting point in view of the fact that Terman advises as bare a room as possible for his "naming sixty words" test.

2. Correlations between the empty and crowded situations yielded a coefficient of .63 when all words were considered and one of .89 when repetitions were excluded.

3. These children gave fewer words in each half minute than did Terman's 10-year-olds, and there was a tendency for the percentage of words to decrease in successive half-minute periods, a finding which is also in agreement with Terman's.

4. In all but one case repetitions averaged less than 2 words, but the percentage of repetitions were greater than those found by Terman.

5. Fewer outside associations were given in the crowded room than in the empty room.

6. Correlations with I.Q. were .14 for the crowded and .10 for the empty room.

7. Sex differences were small, in most cases favoring the girls. The boys scores improved in the second experimental period when they were familiar with the situation; and the difference favoring the girls was less when repetitions were counted out. This suggests that girls are more talkative while boys have more associations.

8. Throughout there were small but consistent differences between children from occupational classes I and II and those from classes III, IV and V; children whose parents belong to the higher occupational classes had more association.

9. Data were available on other traits for 29 out of the 60 subjects. Correlations of the combined C and E association scores with Marston ratings and with ratings on talkativeness

gave coefficients so low as to come within the limits of chance.

10. Correlations of .62 and .42 were obtained between nursery school attendance and E and C scores respectively; these became .33 and −.54 when C. A. was partialled out.

11. Correlations between associations and C. A. were .60 for E scores and .78 for C scores.

REFERENCES

(1) GOODENOUGH, FLORENCE L.: Inter-relationships in the behavior of young children. Child Develop., 1930, 1, 29–47.

(2) TERMAN, L. M.: Measurement of intelligence. Cambridge, Houghton, Mifflin, Co., 1916, pp. 362.

(3) TERMAN, L. M.: Stanford revision and extension of the Binet Simon scale. Baltimore, Warwick and York, 1917.

Learning of Children in Adaptation to Mirror Reversals

EUGENIA KETTERLINUS

THE mirror drawing experiment has been considered of special importance for the study of the trial and error method of learning by adults. The assumption has been made that few habits have been established of hand and eye coordinations under conditions that require the observation of movements in the mirror. Especially is this true of the child under six years of age, who ordinarily makes few motor adaptations to objects seen only in a mirror. The analysis of the learning process of the child under such conditions is the problem of this investigation.

An historical survey of the literature on this problem, namely, the adaptation of the preschool child to the mirror situation, cannot be made, as no work has been published to date on the reaction of young children to mirrored presentations. The nearest approach to work with preschool children is that of Clinton (4) who continued the work of Pyle (11) with fourth to eighth grade children, down to third, second, and even first grade children. A brief review of mirror drawing as a psychological experiment is given.

Mirror drawing, as a bona fide psychological experiment, makes its first appearance in print in Henri's (7) monograph, *Ueber die Raumwahrnehmungen des Tastsinnes*, published in 1898. In this book, dealing with tactual space perception, only a page and a half is given to the mirror drawing experiment, which is simple in character but has all the essential elements of the later more elaborate set-ups. No data are given as to the number of subjects who tried this experiment, nor the number of trials they were given.

Henri (8) goes more into detail about the mirror drawing experiment in his article *Revue général sur le sens musculaire*, which differs somewhat from the original experiment. Instead of two points to be joined by a straight line, he used a straight line, drawn at an angle of 45° at the right of the paper, and asked his subjects to draw lines parallel to the model line. He had two subjects besides himself, and all three of them had considerable difficulty in drawing straight lines. Henri did not keep time but recorded the number of trials necessary before a good copy was made. He reports that in one case 200 repetitions were necessary before a straight line was achieved.

In 1905, Dearborn (6) used the six pointed star as the figure to be traced in his mirror-drawing experiment, but he did not publish a description of it until 1910. Dearborn considered the use of mirror-drawing as valuable in giving the student an opportunity for first hand experience with the trial and error method of learning. He says: "There is some advantage in an experiment which will indicate that the trial and error method is, in certain conditions, regularly employed in adult human learning. The student is apt to get the impression from the usual discussion that trial and error, as a method of learning, is confined to animals and children."

In 1907–08 (not published until 1910), Burt (2) gave a series of tests, intended to test general intelligence, to a group of elementary school boys and to a group of preparatory school boys. Among these tests was one using a mirror. Burt gives credit for the idea of using a mirror to Mr. Keatinge but says he, himself, devised the test as used. This test differs from any used before in that there is no actual drawing. The set-up, aside from the mirror and screen, consisted of a thick cloth laid upon a firm table; on the cloth was placed a sheet of paper and upon the paper was pinned a sheet of stout millboard pierced with eight holes arranged in the form of a circle 20 cm. in diameter, with a ninth hole in the center. The reactor was required, using a blunt mounted needle to punch through the holes in the cardboard, thus leaving a pattern in the paper beneath. The holes had to be punched in a certain order, and the time taken to punch all the holes was kept. For the elementary school boys, Burt reports a correlation between this test and estimated intelligence of 0.67, P.E. .07; for the preparatory school boys a correlation of 0.54, P.E. .14.

In 1910, Starch (13) used mirror-drawing for his experiment in cross-education. He used Dearborn's set-up and six pointed star. His procedure was to trace one star with his left hand and then he traced 100 stars with his right, tracing only one a day. Then he traced one star with his left hand. His right hand improved 92 per cent in accuracy and 84 per cent in speed, his left hand improved between the first and second trials 81 per cent in accuracy and 85 per cent in speed.

D. S. Hill (9) used the mirror-drawing experiment with thirty elementary and thirteen preparatory school boys and reported the experiment very satisfactory to illustrate the learning process.

On December 8, 1913, Hill (10) had one of the same subjects whom he had used in the above experiment repeat that experiment in order to see how much relearning would be necessary. This subject had had his last trial in mirror-drawing on December 20, 1910, when his time had been 24 seconds. On December 8, 1913, after an interval of nearly three years, his time on the first trial was 36 seconds. His original first trial had been 107 seconds. Hill concludes from this that there is very little trial and error learning after the first few trials.

Inappropriate as it may seem, it is the work of Weidensall (14) on *The Mentality of the Criminal Woman* which was a real contribution to make toward the understanding of the reactions of certain children in the preschool group used in this investigation. Dr. Weidensall says that the mirror-drawing test served better than any other used at Bedford to isolate the women who were incapable of sustained effort or emotional control, and certainly the behavior of some of my small subjects suggests that the mirror situation is an excellent one for revealing emotional instability.

Dr. Weidensall gave the mirror-drawing test to 69 of the Bedford Reformatory women, 16 college maids, and 36 college students. The instructions were the same as given by Whipple (16). In both first and last stars (5 in all), both as to time and errors, the three groups are consistently arranged in the same order with respect to percentile records, average and limiting scores. The students have the fewest errors and quickest time, the maids are intermediate and the reformatory women have the slowest time and greatest number of errors.

> "The test isolates" says Dr. Weidensall, "the extremely low grade feeble minded, who, no matter how hard they try, cannot succeed in tracing a precise star. The epileptics have a characteristically bad time and their stars are all knotted up with 'blind spots' where they are caught and held indefinitely. . . . . Chiefly however, is the test of interest in the case of those who are clever enough but too unstable to trace the star well. These are invariably the girls who are difficult to manage in the institution. The tracing goes well enough until suddenly, at a hard point, the pencil starts, and persists upon going, in the wrong direction. The subject then tugs and pulls, grows more and more irritated, disturbed and excited, makes big black circles and unprofitable markings, soon loses all control of herself, and finally throws down the pencil and gives up. . . . . No other test has so conspicuously precipitated this state of instability on the part of the more excitable inmates, who work well as long as they meet with easy success, but who have not reserve force or stability in the fact of a difficult situation which demands of them patience and perseverance."

Cooke (5) also has something to say regarding the diagnostic possibilities of mirror-drawing experiments. He gave the star to a group of high school boys and reports that: "As a personal study this test was very interesting, showing traits of nervousness, carefulness, persistency, and lack of concentration."

In 1918 a description of a new apparatus is given by G. R. Wells (15) which has the advantage of automatically counting the errors made. This device consists of a small brass star inside of a larger brass star with a cement path between the outer edge of the small star and the inner edge of the large star. The cement is flush with the top of the stars. The subject is to trace the cement path with a stylus, which is hooked up to a recording device, so that when it gets off the path onto the brass that error is recorded. This apparatus has the disadvantage of giving no permanent record of how far off the path the subject wanders.

An exhaustive study of tracing the six-pointed star, by G. S. Snoddy (12), was published in 1920. The apparatus used was something on the order of the one described by Wells (15), a brass star being used on glass. Snoddy had 21 subjects, 9 graduate students used for objective data and introspection, and 12 advanced students for objective data only. The most interesting data in this investigation from our point of view are the introspections, which are suggestive. As they are very long, only one will be quoted. A representative one seems to be Observer 3, who, on the first day of his practice had this to say:

> "As soon as I heard the signal, I proceeded to follow the arrow. Then my stylus struck the niche up on the first side. I did not know I was moving in that direction until I struck the side; I tried to push away but found I was pushing against the side. I attempted two or three times to get away but could not; I thought the electric current must be holding the stylus against the sides; I was aware of intensive strains in my arm and the whole affair was very unpleasant. Finally, I gave up and relaxed for a time. I again looked at the star and found that my stylus had moved partly out of the niche during my relaxation. I attempted to get away but drove the stylus back into the niche again. Then the muscles of my arm and shoulder tightened and, with a quick movement, I pulled the stylus out of the niche and down past the arrow."

For a less extended historical survey, read Carmichel (3), and since his article appeared we have the interesting work of Bray (1) and of Clinton (4) published in 1928 and 1930 respectively. Bray's investigation is a combination mirror-experiment and accuracy-experiment, devised to study transfer of learning from hand to foot. The procedure was the same for both the hand and foot experiments. In the hand experiments, the subject sat at a table placed against a wall; on the wall was a target consisting of a cross drawn on a sheet of white paper (in later experiments the cross was changed to a simple vertical line bisecting the paper), which could be seen only by means of a mirror placed on the left. The subject placed his arm under the screen on a marked spot, directly in front of the center of the cross. In his hand was a pencil, with which he was told to hit the cross in time to a metronome beating at 72 per minute. Each subject was given 10 hits, then a rest period of 2 minutes, and then began again with a new target. Each 10 hits was called 1 trial, and 10 trials were given a day. In the foot experiment, the subject sat in an elevated chair with his thigh in a rest. This rest was directly in front of the target, so that the foot hung in front of the mark. A group of 14 subjects were given 60 trials with the right hand and then 40 trials with the right foot. A second group of 14 subjects were given only 40 trials with the right foot only. The group which had had the hand practice showed increased initial accuracy with the foot. Other similar experiments were made and a transfer of learning from right hand to right foot was shown.

Clinton used a pattern having the numbers 1 to 24 inclusive, arranged in two circles. Numbers 2, 5, 8, 11, 14, 17, 20, and 23 made up the small inner circle, and numbers 1, 3, 4, 6, 7, 9, 10, 12, 13, 15, 16, 18, 19, 21, 22, and 24 made up the large outer circle. A small dot located at each numbered point of these circles was to be cut by a continuous line from 1 to 24. Each subject's score was the number of lines completed during a five minute period, and if a whole pattern was completed within the time limit, a second sheet was given. For grades 1, 2, and 3, a pattern sheet was designed with numbers from 1 to 15.

The data were obtained from 1903 unselected students in four school systems, consisting of one group of elementary school students, two groups of high school students and two groups of university students in educational psychology. Clinton finds practically no relation between mirror-drawing ability and general intelligence as measured by I.Q.'s. The most interesting feature of Clinton's work is the indication that age is an extremely important factor in mirror-drawing ability. He has averaged the scores in each year from six to seventeen, for boys and girls separately, and finds a definite improvement in the score at each age, except that the 12 year old boys did not do quite as well as the 11 year old boys.

APPARATUS AND PROCEDURE

Three forms of procedure were used, graded from a simple to a difficult performance. This grading was conjectural but based upon experience with children between the ages of one and a half to six years of age, and upon knowledge of their abilities as measured in other test situations. It was known that they could not trace a star, nor even a straight line accurately, in direct vision.

The subjects were children in the Child Institute of the Johns Hopkins University, ranging in age, at the time of the beginning of the experiment, from two years and one month to five years and four months. Only one child was over five, the next younger being four years and seven months. There were 19 boys and 8 girls.

Twenty-eight children started this experiment, only one child did not complete it. This one child left school after the second week of the experiment, because of illness and did not return. Of the 27 children who completed the experiment, twelve were below three years of age, six were below four years of age, eight were below five years of age, and one was over five.

The apparatus for each form of procedure will be described in the section giving the experimental results for that form.

PROBLEM I

A mirror, 30 by 25 centimeters, hung between two uprights so as to permit adjustment at various angles, was placed at the back of a table 51 centimeters high and 43 centimeters square. In front of the mirror was placed the board, 36 centimeters wide and 33 centimeters deep, containing the test objects. On the extreme left of this board, and midway from the front to the back, a tin cup 6.5 centimeters in diameter and 5 centimeters in height was screwed. The outline of the three objects was drawn on the board so that they could be replaced in exactly the same positions. These objects were a spoon, 5.5 centimeters in length, placed 28 centimeters from the front edge of the board and 18 centimeters from the right hand edge; a white pearl button 2 centimeters in diamenter placed 20 centimeters from the front edge of the board and 8 centimeters from the right edge; and a ball 2 centimeters in diameter, made of clay with one side flattened so that it would not roll, placed 9 centimeters from the front and 20 centimeters from the right. A cross was made at the front of the board 7 centimeters from the right edge. This board, with the objects in position, was placed on the table with its front edge flush with the front edge of the table. For a screen to cut off direct vision, a piece of thin board was used, as being more substantial than the usual cardboard, in anticipation of the children leaning on it and trying to look under. This board was 38 by 25 centimeters and had a strip of light wood nailed to it and extending beyond it 10 centimeters, which was clamped into an ordinary adjustable laboratory support fastened to the right of the table.

The first time that the child was brought in to "play the game," the mirror was on another table and the screen swung around to the right out of the way, so that the board with the cup and three objects was in plain sight. This was for the control test, each child being given one trial with direct vision so that the time normally required by the child to complete the task would be known and could be used to check the amount of slowing up caused by the mirror reversal. The child was seated in a chair, its seat 35.5 centimeters from the floor, which was then moved up close to the table. The observer then took the child's right hand, placed it on the cross marked on the board, and held it there, saying:

> "See the things on the table, when I say 'Go' you are to pick up the ball and put it in the cup, then pick up the button and put it in the cup, and then the spoon, as quickly as you can. Understand? You are to pick up the ball and put it in the cup, then the button, and then the spoon.
>
> Get ready—Go—Put the ball in the cup."

If necessary, that is, if the child hesitated after the ball was put in the cup, the observer prompted with "Now the button" or "Now the spoon" or both, as the occasion required. Time was kept with a stop watch from the release of the child's hand at "Go" to the sound of the spoon hitting the bottom of the cup.

Then the child and chair were pushed back, the child being allowed to get up if he wanted to. The observer swung the screen around into position, replaced the objects on the board, put the mirror on the experimenting table and moved the child up to the table again, saying,

> "I want you to do exactly what you did before, first put the ball in the cup, then the button in the cup and then the spoon, but now you cannot see them except in the mirror, which makes things look differently, and you will have to watch where your hand goes in the mirror so that you can pick them up and put them in the cup. Can you see the ball and the button and the spoon and the cup?" If the child said "No," the mirror was adjusted until he could see all four. Then the observer placed the child's right hand on the cross and asked if he could see that, too. Then the observer said, "When I say 'Go' do just what you did before, pick up the ball and put it in the cup, then the button and then the spoon. Ready,—go."

As before, the observer prompts as to which object is to be sought next. Time was kept from the release of the child's hand to the tinkle of the first object as it landed in the cup; from that second until the next object was dropped into the cup; and from the placing of this object until the sound of the final object hitting the bottom of the cup. Time was the only score used because, as there was no record of the child's movements made, no accurate count could be made of errors; but after each trial, the observer wrote down anything unusual that occurred, such as the child's dropping an object, or knocking it off the board, or changing from one hand to another, or persistently overreaching, etc.

Two trials were given each day, the second trial immediately after the first. After the objects were replaced, the observer said, "You did that very nicely, now see if you can do it even better this time. Do just what you did before." The trials were given in a series of four days, one week apart. This schedule of one week apart was adhered to as nearly as absences and holidays would permit, and in the majority of cases was carried out exactly.

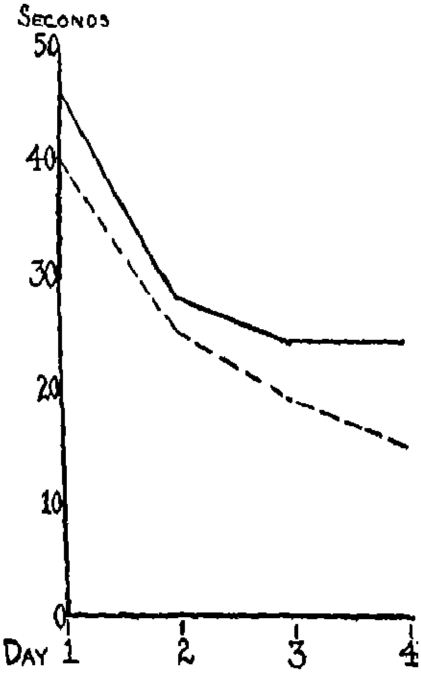


FIG. 1. MEAN TIME, FOR PUTTING OBJECTS IN CUP

——— first trial;---------- second trial

Results

The first experiment shows conclusively that four, three, and even two year old children can learn to inhibit established habits and can rapidly acquire new ones. The mean score for all three age groups combined shows a definite improvement, not only from day to day, but also of the second trial over the first (see fig. 1). Taking the age groups separately, we find a somewhat different picture, although the final result is the same, that is, the final mean score for each group is the lowest mean score for that group. The four year old group shows the fewest irregularities, which might be expected on the basis of their comparative maturity, but the three year old group shows more irregularities than does the two year old group, which may be due to the influence of individual differences because of the few subjects in this group. (See fig. 2).

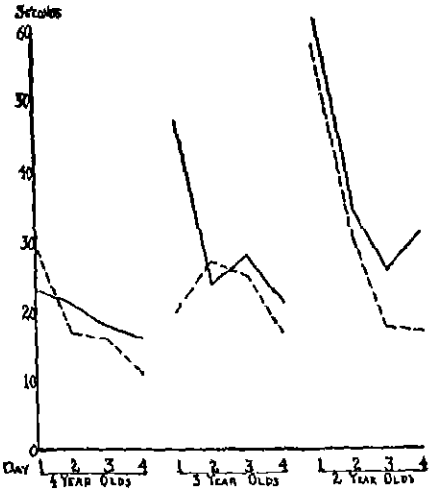


FIG. 2. COMPARISON OF THREE AGE GROUPS

——— first trial;---------- second trial

The mean scores of the four year old group show an improvement on each successive day, but on the first day the second trial is a decided slump over the first, due to subject Dl's getting badly "lost" trying to reach the spoon, and subject F having a similar difficulty with the button.

In the three year old group there is a slight regression in the first trial on the third day, and the second trial on the second day is not only worse than the second trial on the first day but is inferior to the first trial on the same day. The second trial improves slightly on the third day but not up to the standard set by the second trial on the first day. The vagaries of the second trial on the second and third days are due to one subject, I, who got stuck on the ball on the second day and the spoon on the third day. The explanation of the slowing up of the first trial on the third day is that three subjects, I, L, and Ll, slowed down on their time for putting each object into the cup.

The two year old group shows a consistent improvement from day to day on the second trial and on the first trial with the exception that the fourth day's score is five seconds slower than the third day's score.

All the mean scores referred to above are for the complete test, that is, the time required to put all three objects into the cup. The time for putting each object into the cup was kept for two purposes, first, in order to show up wide fluctuations in scores, for which it has proved invaluable, and second, on the theory that one position on the board might offer greater difficulties than another. This latter idea is not supported by the facts, for a careful scrutiny of the mean scores for specific objects in all three age groups combined shows no particular differences in their relative difficulty, therefore all scores mentioned, unless otherwise specified, will refer to the time required to complete the test.

Although there are decided individual differences shown they are not as great as were anticipated. The subjects who got "lost" once, tended to do so again. In all three groups there is not one case in which a subject gets "lost" after the second day, unless he has been "lost" earlier, and only one case in which the first trouble of this kind appears on the second day. On the other hand those subjects who got lost on the first day, in spite of marked improvement, might suddenly get badly stuck on one object even on the fourth day.

Four year old group. The shortest time on the first trial in the four year group was made by subject C, four years and five months old. This time was 9 seconds and he also made the shortest final trial, time 6 seconds. (See table 1.) It is interesting that 6 seconds is also his time without the mirror. This subject is the only one who brought his mirror time down to his time without the mirror, although a number of others reduced their time to within a few seconds of their direct vision time.

The longest first trial in the four year group was made by subject B, aged four years seven months. Her time was 50 seconds, twenty-nine of which were spent trying to locate the button. On the final trial she had reduced her total time to 17 seconds. For a comparison of her complete performance with that of subject C consult figure 3. The longest time taken by any child in the four year group was in the second trial on the first day by subject Dl who took 60 seconds. He

TABLE 1

SUBJECTS	1ST DAY		2ND DAY		3RD DAY		4TH DAY		TIME WITHOUT MIRROR
	Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2	
Four year old group—time in seconds									
A	23	20	42	20	25	35	20	14	8
B	50	31	22	17	22	22	42	17	6
C	9	12	12	19	18	11	11	6	6
D	17	25	22	15	15	16	11	9	6
D1	13	60	18	15	15	10	13	9	6
E	35	30	33	22	30	16	19	13	9
F	26	56	17	18	17	13	15	9	8
G	18	9	12	18	10	14	8	7	5
H	20	15	18	9	12	11	10	12	5
Totals...	211	264	196	153	164	147	149	96	61
Mean....	23.4	29.3	21.7	17.0	18.2	16.3	16.5	10.6	6.7
Three year old group—time in seconds									
I	54	55	45	79	56	77	32	23	11
J	22	18	13	10	12	12	11	10	5
K	43	9	25	23	14	10	22	27	7
L	120	18	21	21	30	14	19	14	7
L1	17	13	20	15	40	20	16	13	7
M	29	12	19	17	16	22	27	20	11
Totals...	285	122	143	165	168	155	127	107	48
Mean....	47.5	20.3	23.8	27.5	28.0	25.8	21.1	17.8	8.0
Two year old group—time in seconds									
N	51	28	10	18	39	15	11	12	9
N1	24	23	64	29	46	23	64	21	8
O	20	20	25	15	20	26	20	10	9
P	35	13	21	25	34	20	20	23	7
Q	21	30	37	24	22	11	28	13	9
R	179	183	43	45	27	17	82	25	10
S	25	13	30	16	20	14	24	13	12
T	122	81	19	18	28	18	21	15	8
U	40	27	20	35	16	10	15	13	10
V	80	222	117	78	18	37	20	15	14
W	37	21	22	32	20	18	25	10	9
X	118	43	20	30	30	18	49	35	17
Totals...	752	704	428	305	320	227	379	205	120
Mean....	62.6	58.6	34.0	30.4	26.6	18.3	31.5	17.0	10.0

reduced his time on the final trial to 9 seconds, his time without the mirror was 6 seconds.

Of the nine subjects in the oldest group, eight made their best score in the final trial, and one subject made his best time in the second trial of the second day. This was subject H, the youngest child in this group. He did remarkably well throughout the experiment, his highest score, which was on the first trial on the first day was 20 seconds and his final score 12 seconds.

Three year old group. The shortest first score in the three year group was made by subject Ll, three years and seven months old. (See table 1). Her time was 17 seconds, which is considerably slower than the best first score in the four year group. Subject Ll did not make the best final score by four seconds, and her final score, 13, she had equalled on her second trial on the first day. Her time without the mirror was 7 seconds.

The longest first score in the three year group was made by subject L, aged three years and eight months, time 120 seconds, more than twice the longest first score in the four year group. This is the longest time on any trial in this whole group. She reduced her time in the second trial on the third day and in the final trial to 14 seconds, her time with direct vision was seven seconds.

The most consistent good record in the three year group was made by subject J, aged three years and eleven months. His highest score in the whole series being 22 seconds, made in the initial trial, and his lowest score 10 seconds, made in the second trial on the second day and in the final trial.

The most erratic record, due to the subject's tendency to get "lost" was made by Subject I, whose worst score was 79 seconds, on the second trial on the second day, and whose best score was his final score of 23 seconds. Time without the mirror eleven seconds. For a comparison of the complete performances of these two contrasted subjects, see figure 3.

Of the six subjects in the three year old group, only one made his best score in the final trial, subject I. Three subjects, J, L, and Ll, did as well in the final trial as they had done once before. Two subjects, K, who made the best time of all in this group, 9 seconds, and M, made their best time on the second trial on the first day. Subject M, whose record shows the least consistent improvement without any spectacular set backs, is the youngest child in this group, being three years and four months old.

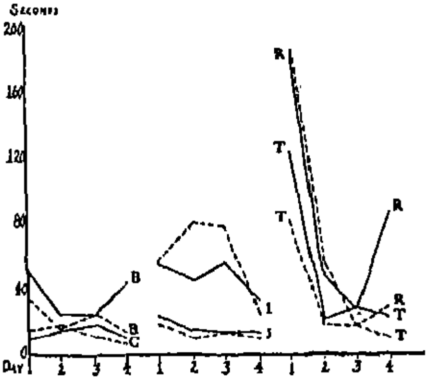


FIG. 3. EXAMPLES OF INDIVIDUAL DIFFERENCES FROM EACH AGE GROUP

——— first trial; - - - - - - second trial

Two year old group. The lowest first score in the two year old group was made by Subject O, aged two years and nine months. (See table 1.) The score was 20 seconds, not much slower than the shortest first trial in the three year group. This subject had little difficulty with the test, his poorest time was 26 seconds, made on the second trial of the third day, and his final trial, 10 seconds, was one of the two best final trials made by this group. His time without the mirror was 9 seconds.

The longest initial trial, 179 seconds, in the two year group was made by Subject R, aged two years and eight months. This time is almost a whole minute slower than the longest first trial in the three year group. The slowest time in this whole group was made by this subject on his second trial on the first day, 183 seconds, Subject R's final score was 25 seconds, but his best score, made on the second trial on the third day, was 17 seconds. A comparison of R's performance with Subject T's (fig. 3) is interesting as an example of two subjects who both start badly, but one of whom shows almost steady improvement while the other gets into difficulties even on the last day.

Half of the subjects in the two year old group made their best score in the final trial, one did as well in his final score as he had done once before. Of the other five subjects, one made his best score on the second trial on the first day, three made their best scores on the second trial of the third day, and one on the first trial of the last day.

Summary

Clinton's conclusion that mirror drawing ability develops from year to year is strikingly upheld by a comparison of the performance of the three age groups. In the first trial there is practically no overlapping of the groups,—although on the third day the two year olds do better than the three year olds by two seconds. In the second trial there is some overlapping between the three year group and the other two groups, but none between the two and four year groups.

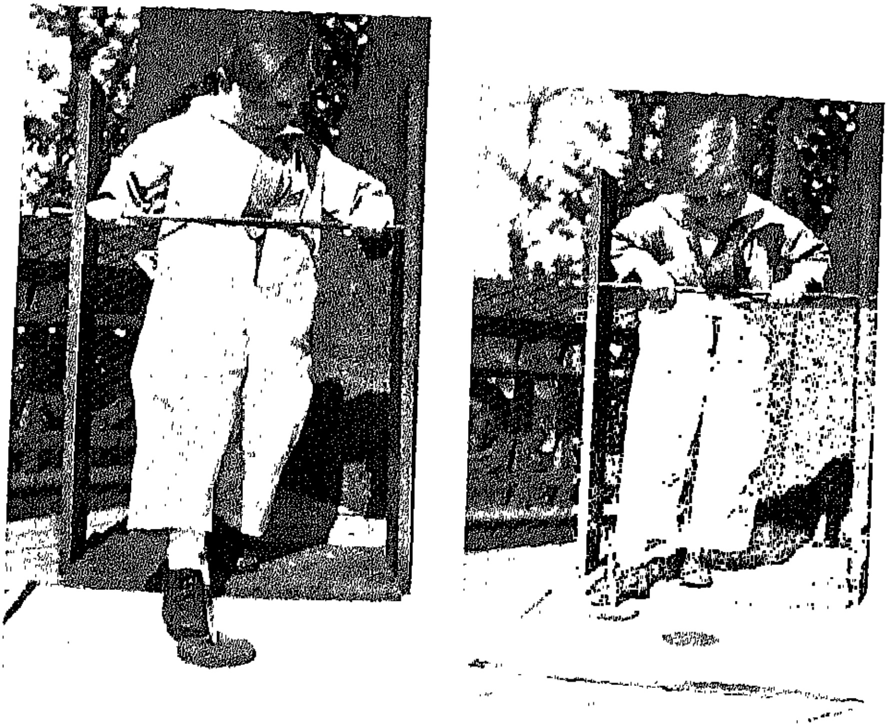
PROBLEM II

The subjects were the same as those used for Problem I, except that five had left school or were absent for such long periods that they could not be used. Of these children, one belonged to the four year old group, two, unfortunately, belonged to the three year old group, reducing it to only four members, and two were in the two year old group. This left 22 subjects who completed Problem II.

Apparatus and procedure

For the foot experiment, a large mirror was used, 92 centimeters square. This mirror stood upon the floor inclined against the wall of the experimenting room. Suspended from a wire above the mirror was a curtain which could be lowered to conceal the mirror. In order that the subjects would have something to hold on to while standing on one foot, an adjustable rack was used. This rack consisted of two boards, 15 centimeters wide and 92 centimeters long, nailed at right angles to the ends of a thick plank of corresponding width and 61 centimeters long which was used as the base. The boards used as uprights had holes 1.5 centimeters in diameter bored 5 centimeters apart in a per-

PLATE I



pendicular line to the base, along the outer edge. An iron rod inserted in the holes at about the right height for the child to hold thus gave a solid support for the child to grasp with both hands. In this way he could stand on his left foot and move his right foot freely without losing his balance (Plate I). Only three heights were actually used in this experiment. The stand was placed 123 centimeters in front of the mirror.

On the floor directly in front of the stand was laid a piece of beaver board 54 centimeters wide by 67 centimeters long, to which the sheets of paper for individual records were fastened with thumb tacks. The paper used for the records was Congress linen bond, cut in sheets 48 centimeters wide by 60.5 centimeters long. In the center of each sheet of paper a circle was drawn 10.5 centimeters in diameter. This circle was filled in solid with yellow paint.

The disc which the subject was to push with his foot, was of wood, 10.5 centimeters in diameter, and one centimeter in thickness. It was painted yellow to correspond with its destination. In the center of the disc a hole was bored to permit the insertion of the point of a large lead pencil. This pencil had a wire loop fastened just below the eraser, which was turned down toward the point of the pencil. A heavy strip of rubber, in length a little less than twide the distance from the loop to the point of the pencil, was passed through the loop and then both ends were pinned down together to the disc, as close to the edge of the hole as possible, in order that the pull of the rubber would force the pencil through the disc and thus make a mark whenever the disc was pushed along a smooth surface. Of course the pencil had to be adjusted from time to time, the point needing to be sharpened and the rubber stretched tighter to maintain the same tension, as the pencil grew shorter.

For a screen, a piece of card board 41 centimeters wide by 80 centimeters long was used. This screen was laid above the record sheet 53 centimeters from the floor, one end of the screen resting on a table, the other supported by a wooden box of corresponding height, one edge flush with the edge of the stand. In the case of the smallest children, the bar of the support was flush with the edge of the screen. Clamped to the edge of the table, underneath the screen, was an electric light, used on dark days to counteract the cutting off of light by the screen.

No record, other than time, was kept on the trial without the mirror, because the movement was so simple that there was practically no variation. For the direct vision trial, therefore, one record sheet was kept permanently fastened to a piece of beaver board and used over and over again. When the subject entered the experimenting room, the curtain was lowered over the mirror and the try-out sheet in position on the floor in front of the stand. The screen had been removed. The observer said: "Stand in here" indicating the space between the two-uprights of the stand, "and hold on to the rod with both hands. Then you are to put your foot on this yellow block and push it onto the yellow circle, like this." (Demonstration). "Now, when I say 'Go' push the block onto the circle. Ready, Go."

After this had been accomplished, usually within a few seconds, the practice board was removed and replaced with the other similar board, with a fresh record sheet fastened to it with thumb tacks. The screen was put in position, the curtain lifted from the mirror, the disc placed on the record sheet in the lower right hand corner, with its rim 3 centimeters from each edge of the paper, so that movement could be made in any direction. The following instructions were then given: "Now do just what you did before, put your foot on the block and push it onto the yellow circle, when I say 'Go,' but this time you must look in the mirror to see where your foot is. Ready, go." Time was kept with a stop watch from "Go" until the subject completed the task to his own satisfaction, or until three minutes were up.

Only one trial was given each day, and only three trials were given, at intervals of three days with some exceptions. If a subject had his first trial on Thursday, he had his second on the next Monday and his third on the following Thursday.

The problem of scoring the records was a difficult one. A wooden frame was constructed the size of the record sheet. Tacks were placed on the frame at intervals so that a string pulled taut across the frame made blocks 15 centimeters square. At least the bottom and middle rows were square, the top row was several centimeters larger from top to bottom as the paper was not square, but this did not matter because the subjects could not reach quite to the middle of the top row. There were four squares from left to right and three from top to bottom. The middle line from top to bottom ran directly through the center of the circle. Thus, if the disc were pushed straight to the circle, it would traverse but one square. If the disc were pushed far enough to the left to get into the second square from the right side of the frame, that was counted one error to the left, if it were pushed into the third square from the right side of the frame that was counted two errors to the left. If the disc were pushed up into the middle square at the right, that was counted one error "up," and so on. Of course this system takes into account only gross errors with one exception: if the disc were moved percentibly to the right, or down, in the starting square this counted one error, as it could not possibly be moved more than three centimeters in these directions, as it came up against the box or stand; but as the movement was a gross one, this method seems admissible. Errors were only counted when the goal was attained within the time limit of three minutes. In the case of six subjects in the two year group, the stand was placed six centimeters on the record sheet so that the subjects could reach the goal.

Results

The results of the second experiment show a more definite cleavage in the abilities of the age groups than do the results of the first experiment. The three and four year old groups can be said to have mastered the problem in the three trials given, with the exception of one subject, J, whose difficulty was emotional and whose case will be discussed later. The two year old group on the other hand seems, on the third day, to have reached about the stage of performance shown by the two older groups on the first day. That is, the average time of the 9 subjects who completed the experiment on the third day was 74.3 seconds and that of the four year old group on the first day was 74.5 seconds; the three year group (three subjects) has a lower

TABLE 2

Time and error record for age groups in experiment II

SUBJECTS		TIME WITHOUT MIRROR	1ST DAY		2ND DAY		3RD DAY	
			Time	Errors	Time	Errors	Time	Errors
		seconds						
Four year group	A	8	78	2	103	3	27	3
	B	10	127	6	9	1	9	4
	C	3	21	4	14	1	17	3
	D	4	20	3	11	4	7	1
	E	15	168	5	32	3	30	5
	F	5	18	5	18	4	5	3
	G	15	45	8	109	9	58	5
	H	3	119	8	97	5	25	1
Totals			596	41	393	30	178	25
Mean			74.5	5.1	49.1	3.7	22.2	3.1
Three year group	I	8	66	5	85	5	9	2
	J	10	DNC	—	DNC	—	DNC	—
	L	5	12	2	10	0	10	1
	M	4	34	1	62	12	50	7
Totals			112	8	157	17	69	10
Mean			37.3		52.3		23.0	
Two year group	O	8	17	1	DNC	—	81	7
	P*	10	DNC	—	16	2	50	3
	Q	10	DNC	—	DNC	—	110	5
	R	8	DNC	—	72	9	99	4
	S	5	86	3	DNC†	—	10	3
	T*	3	66	8	103	5	35	5
	U*	3	25	1	17	4	17	1
	V*	11	DNC	—	DNC	—	DNC	0
	W*	7	70	1	93	12	13	2
	X*	4	DNC	—	DNC	—	40	3
Totals			264	14	536	32	669	33
Mean			52.8		89.3		74.3	

* These subjects had the shorter distance.

† Completed after the time limit.

time, 37.3 seconds, due to individual differences, on the second day their time goes up to 52.3 seconds. In the two year old group, on the first day only, half of the subjects completed the experiment, the other half either becoming hopelessly involved in wrong movements or giving up after placing the block less than half-way on the circle. On the second day, 6 subjects succeeded in reaching the goal within the time limit and on the last day all but one were successful.

Both the average time and the average number of errors made by the four year old group shows a steady decrease from day to day as is shown in table 2. This is especially true of the time record, for although the errors decrease they do not fall off as rapidly as the time. In individual cases, there seems to be a discrepancy between the number of errors made and the time taken to finish the task. For example, in the four year old group on the first day, subject H makes 8 errors in 119 seconds, whereas subject F makes 5 errors in 18 seconds. This apparent disproportion is due to the fact that in this experiment a subject tended to become bewildered when his foot went in the wrong direction, and frequently stood without moving at all for considerable periods. In addition to this tendency to stand still on the part of the cautious subjects, there was the over activity of the quick moving child who kept moving his foot regardless of where it went, consequently reaching the goal in less time but with more errors. These two factors are important in all three groups.

In the four year old group, five subjects, A, D, E, F, and H made their best time score on the last day, and D, F, G, and H also made the fewest errors on the last day. The other subject, A, made his fewest errors on the first day. The fastest first score made in this group was 18 seconds, by subject F, who also made the best time on the last day, 5 seconds. Subject B was the slowest on the first day, taking 127 seconds, but she reduced this to 9 seconds the second day and took 9 seconds again on the last day.

The three year old group was composed of highly individualistic subjects. Subject J, after 65 seconds of fruitless effort, gave up, saying: "I don't want to do it any more. I want to go back to the other room." He kept on refusing to try any more until his three minutes elapsed. On the second day, he tried for 31 seconds, and then refused flatly to make any further effort. On the third day, he refused even to start. This subject is both spoiled and stubborn, and would not try to overcome the difficulties. In contrast to J's behavior is that of S who struggled on, almost weeping but determined to finish, succeeding in 3 minutes 50 seconds. Because of the time limit, he had to be scored D.N.C., but he was so absorbed and anxious to succeed that the observer let him continue over time.

The three year old group also contained subject I, whose tendency to get "lost" had appeared in the first experiment, and who ran true to form on the second day, running his time up to 85 seconds when it had been 66 seconds on the first day. He redeemed himself on the last day, cutting his time to 9 seconds and making only 2 errors. The only errorless record made in the whole experiment belongs to subject L in this group. She also made the fastest time on the first day in any group, 12 seconds with 2 errors. On the second day she did it in 10 seconds with no errors, and on the third day in 10 seconds with 1 error. The other subject in the three year group, M, made the goal in 34 seconds with only 1 error on the first day, which must have been chance, because on the second day he wandered all over the paper, making 12 errors, and on the last day he improved only a little, bringing his time down to 50 seconds and his errors to seven.

The situation which developed in the two year old group is difficult to account for, in view of the performance of this group in the first experiment. Had the two year olds been unable to learn the new coördinations thrust upon them by the mirror, well and good, but they learned it with the hand movement, although more slowly than did the older groups, and so just why the foot movement should prove more baffling to them seems obscure. On the first day only half the group met with success, on the second day two more were successful but one who had succeeded the first day failed, and on the third day only one remained vanquished. There is only one subject, U, in this group who made a consistently low record in both time and errors. All the others, on one day at least, took over 50 seconds except the youngest child in the group, X, who on the last day, after two failures, solved the problem in 40 seconds with three errors.

An analysis of the direction in which the errors were made shows the left predominate. (See table 3.)

TABLE 3
Analysis of errors

	LEFT	UP	DOWN	RIGHT
Four year old group	41	10	19	26
Three year old group	13	8	12	2
Two year old group	26	22	23	15
Total all groups	80	40	54	43

Summary

The second experiment shows all three age groups learning new coördinations, but with more individual inconsistences than appeared in the first experiment. This is probably due to there being more of an element of chance success in this experiment, where one chance movement in the right direction brought success, whereas in the first experiment three movements had to be made. Skill in foot movements is probably less developed than in hand movements, and the greater variability might be expected under such conditions. A study of the acquisition of skill in this situation by an adult might throw light upon the relative difficulty of hand and foot coördinations.

PROBLEM III

The subjects in this experiment were the same as those used in Problem II, that is, 22 children ranging in age from two years and one month to five years and four months. Seventeen of them were boys and 5 were girls.

Apparatus and procedure

The set-up for this experiment was the same as that for the first experiment, except the task to be done and the materials for that task. The same table and chair, the same mirror and screen were used as in Problem I. In place of the board, cup, and three objects, a sheet of white paper 35.5 centimeters long by 21.7 centimeters wide was fastened to the table with thumb tacks, the long edge flush with the front edge of the table. On the paper was a path, 4 centimeters wide, running the length of the paper. At one end this path was in the center of the paper, and starting from that end as the right hand end the path ran 10 centimeters and turned at a right angle to the left for 3.5 centimeters, turned another right angle to the right, continued straight for 9 centimeters, turned another right angle to the right, ran straight for 9.5 centimeters and turned at a right angle to the left and continued straight to the edge of the sheet. This was the direction used for the main part of the experiment. For the control test without the mirror, the paper was reversed so that the path started in the lower right hand corner.

A toy cannon, its two wheels 2.3 centimeters apart, was used to push along the path. Underneath the cannon and between the wheels a pencil stub was fastened so that a line was drawn as the cannon was moved along. When the child came for the first time for this experiment, the screen was swung around to the right out of the way, the paper was in place on the table, with the path starting in the lower right hand corner. After the child was seated, the observer said, "See this road that is drawn here on the paper? I want you to push this cannon along that road as fast as you can without getting off the road. Now, hold the cannon this way." The child's fingers were placed around the cannon just above the pencil; "and when I say 'Go' push the cannon along the track, and be sure to stay in the road." Then observer places child's right hand, now containing the cannon, in the middle of the path at the edge of the paper, and says, "Ready, go," at the same moment releasing the child's hand. Time was kept with a stop watch until the cannon reached the other end of the paper, or for the two year olds until three minutes elapsed.

Then the paper was replaced with a fresh sheet turned around the other way, the mirror was put on the table and the screen swung into position so that the path was concealed from view except in the mirror. The child was moved close up to the table and asked, "Can you see all of the road in the mirror?" If not, the mirror was adjusted until he could see the whole path. Then observer placed the cannon in the child's hand and placed the hand containing the cannon in position in the middle of the track at the end of the paper, saying, "When I say 'Go,' do what you did before, push the cannon along the road, being sure to keep in the road, but now you can only see it in the mirror, which you remember makes it look different. Ready, go." The hand was released at "Go." Time was kept with a stop watch until the cannon reached the other end of the paper or until five minutes had elapsed for the three and four year olds and three minutes for the two year olds. Occasionally, the observer reminded the subject that the cannon must be kept in the path.

Two trials were given with the mirror each day, for four days, at approximately three day intervals. That is, the experiments were made on Mondays and Thursdays for two consecutive weeks. In order to score the record of the cannon's meanderings left on the paper by the pencil, the following method was used. A scale of three units was made, each unit being one-third of the distance from the path to the top of the sheet, at the right hand end when the paper was in position for the mirror experiment. The scale was marked on a piece of paper and used to measure the distance the cannon had been pushed from the path. If the cannon were pushed off the track but not further than a distance of 2.8 centimeters the first unit, it was counted one error. If the trail of the cannon was found in the second zone, it was counted as two errors; if in the third zone, as three errors. Thus, if the mark of the cannon was found off the track twice in the first zone, once in the second zone and once in the third zone, the score would be seven errors. The distance was measured from the point at which the cannon left the track to the most distant point that the cannon reached before it returned to the track.

Results

The third experiment shows a clear break between the two year old group and the three and four year old groups. Not one of the two year olds completed this experiment. Of the three year old group, two succeeded and two did not; the two who failed undoubtedly did so because of emotional difficulties to be discussed later. All of the four year old group completed the experiment, but three of them, subjects B, F, and G, failed on the first trial the first day.

Subject F was so upset by her first trial that she was not given a second trial that day, but B and G succeeded on the second trial although their time and error score was well above the mean, as is shown in table 4. On the second day subject F made no objection to tryng again and did remarkably well. On both trials both her time and error scores were below the mean for the group. In fact this subject, with one trifling exception, improved steadily not only from day to day but from trial to trial. Her final score, 11 seconds, with no errors, was the best final score made by anyone, and her time was also the best made by any subject in any trial, although there were three other records made without errors.

The best initial score in both time and errors was made by subject H, 45 seconds and 1 error. He then slumped, becoming worse until on the second trial on the second day his time score was 149 seconds with 6 errors. Then he began to improve slowly and fin-

TABLE 4

Time and error score—four year group

SUBJECTS	WITHOUT MIRROR		1ST DAY				2ND DAY				3RD DAY				4TH DAY			
			1st		2nd		1st		2nd		1st		2nd		1st		2nd	
	T*	E†	T	E	T	E	T	E	T	E	T	E	T	E	T	E	T	E
A	15	1	103	7	153	19	71	4	27	2	35	3	20	4	30	4	19	2
B	30	1	DNC	—	131	13	150	14	130	6	118	10	57	6	59	3	27	4
C	10	1	69	5	36	5	43	3	27	4	32	3	28	4	24	4	17	2
D	17	4	85	11	43	12	55	7	50	14	142	11	80	5	31	5	29	4
E	39	1	265	24	132	7	144	5	63	5	80	3	57	1	67	2	39	3
F	21	0	DNC	—	—	—	59	3	27	5	13	0	12	0	16	1	11	0
G	45	0	DNC	—	250	13	100	6	92	7	29	3	62	5	61	3	65	4
H	35	0	45	1	77	8	135	16	149	6	79	2	76	3	73	4	42	4
Totals....	212	8	567	48	822	77	757	58	565	49	528	35	394	28	361	26	249	23
Mean.....	26.5	1.6	113.4	9.6	117.4	11	94.6	7.2	70.6	6.1	66	4.3	49.2	3.5	45.1	3.2	31.1	2.8

* T is time in seconds.

† E is errors.

TABLE 5

Time and error score

Three year group

SUBJECTS	WITHOUT MIRROR		1ST DAY				2ND DAY				3RD DAY				4TH DAY			
	T*	E†	1st		2nd		1st		2nd		1st		2nd		1st		2nd	
			T	E	T	E	T	E	T	E	T	E	T	E	T	E	T	E
J	34	6	DNC	—	—	—	DNC	—	—	—	—	—	—	—	—	—	—	—
L	30	1	89	21	80	13	128	8	87	5	90	9	57	3	95	8	39	2
I	20	1	DNC	—	—	—	DNC	—	—	—	—	—	—	—	—	—	—	—
M	10	0	DNC	—	—	—	DNC	—	—	—	85	0	130	8	72	3	37	4
Totals....	94	8	89	21	80	13	128	8	87	5	175	9	187	11	167	11	76	6
Mean.....	23.5	2.6									87.5		93.5	5.5	83.5	5.5	38	3

Two year group

SUBJECTS	WITHOUT MIRROR		1ST DAY		2ND DAY	
	T	E	T	E	T	E
O	15	3	DNC	—	DNC	—
P	87	12	DNC	—	DNC	—
Q	16	4	DNC	—	DNC	—
R	45	12	DNC	—	DNC	—
S	DNC	—	DNC	—	DNC	—
T	20	3	DNC	—	DNC	—
U	DNC	—	DNC	—	DNC	—
V	DNC	—	DNC	—	DNC	—
W	8	0	DNC	—	DNC	—
X	DNC	0	DNC	—	DNC	—

* T is time in seconds
† E is errors.

ished with a final score of 42 seconds with 4 errors. H was the youngest child in the four year old group, and the observer believes that the explanation of his record is lack of sufficient motivation. He was interested in the first trial and thereafter became careless, but finally began to improve again.

The longest first trial was made by subject E, 265 seconds, who also in that trial made the most errors, twenty four. E improves with regularity from day to day, his final score being 39 seconds with three errors. (Subject C's record is typical; see Plates II and III.)

In spite of individual differences, the mean of the four year old group shows steady improvement in both time and error scores from day to day and of the second trial over the first, with the one exception that the second trial on the first day is slower and shows more errors than the first trial on the first day. (See fig. 4.) In this group, all but one subject, G, made their best time in the final trial, and of these seven, four also made the fewest errors in the final trial.

In the three year old group, we have two subjects, J and I, who refused to finish the experiment. (See table 5.) J, who with direct vision took 34 seconds and made 4 errors, took his hand away from the cannon after ninety seconds with the statement, "I can't do it" and thereafter refused to revise his opinion. On the three succeeding days, he would accompany observer to the experimenting room without demur, seat himself in the chair and after one or two efforts to make the first turn would desist, folding his hands in his lap and repeating in a whiny tone, "Can't do it."

Although the result was the same, subject I's behavior was very different. With direct vision, he finished in 20 seconds with only 1 error. On the first trial with the mirror, he struggled for 137 seconds and then suddenly shouted, beginning to jump up and down, "It won't go! it won't go!" On being urged to try a little longer, he tried to look under the screen and had to be forcibly restrained. Whereupon he said, "I won't do it any more," and he would not. On the second day something of the same sort occurred, only this time he gave up after forty seconds. On the third and fourth days he pulled the cannon out from under the screen and pushed it along on top of the screen, never once making an effort to do the test as instructed. The observer later tried a special inducement, offering him a cannon like the experimental one to keep, if he would try to do the experiment, but he screwed himself up into a ball of

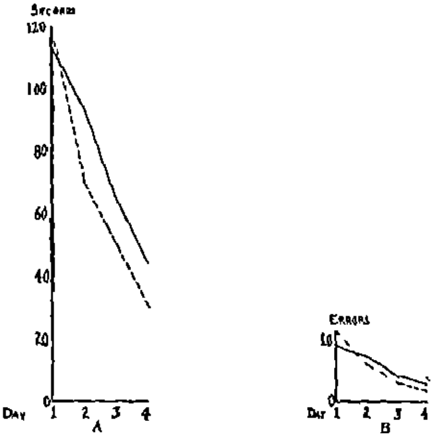
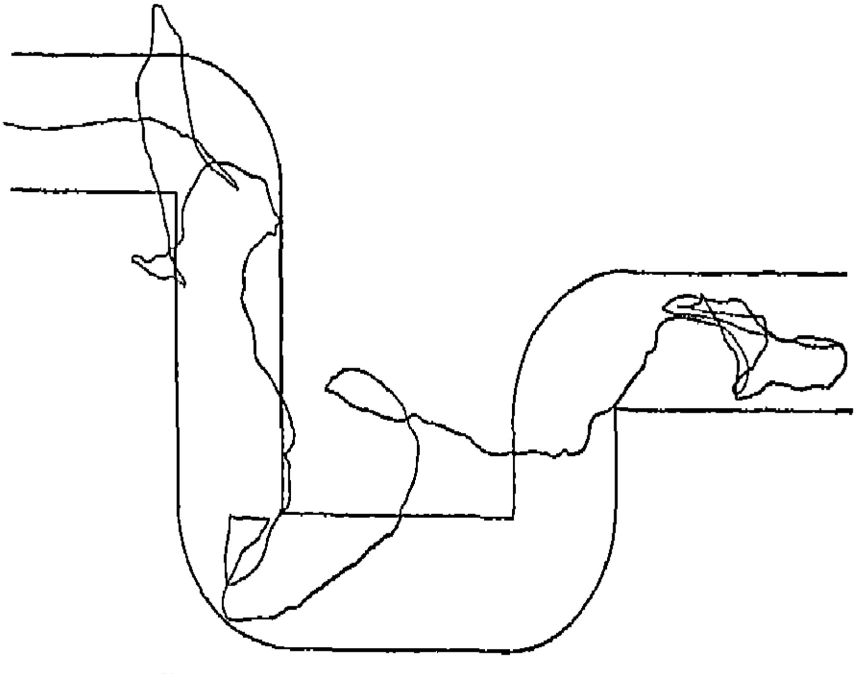
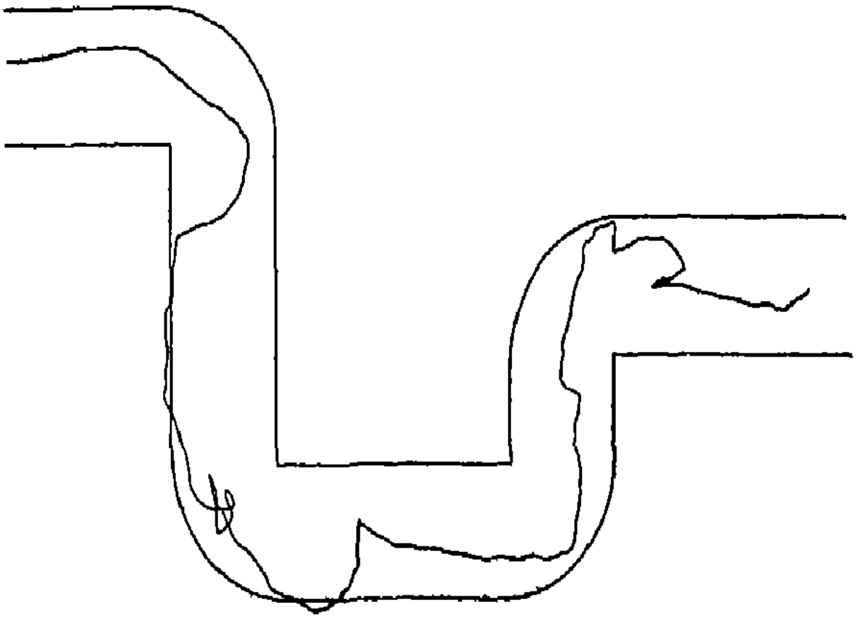


FIG. 4. A: MEAN TIME FOR PUSHING CANNON ALONG PATH, FOUR YEAR OLD GROUP; B: MEAN ERRORS

——— first trial; ----------- second trial



SUBJECT C. FIRST TRIAL, FIRST DAY. TIME: 60 SECONDS; ERRORS: 5



Subject C. Last Trial, Last Day. Time: 17 Seconds; Errors: 2

rebellion and said "It won't go and I won't try to make it go."

Only one subject in the three year old group succeeded the first trial. This was subject L, who took 89 seconds and made 21 errors on the first trial, but in the final trial she had cut down her time to 39 seconds and her errors to two. Subject M, the youngest child in the three year group, struggled valiantly until the five minutes were up, never getting beyond the first curve and remarking once, dispassionately, "It always goes that way," meaning the wrong way. He did not want to try again that day, but came willingly the next experimenting day. This time he succeeded in reaching the last turn just as his time was up, but seemed unwilling to make a second attempt that day. On the third day, he was successful in 85 seconds without a single error, on the first trial. On the second trial, which he wanted to make, he took 130 seconds and made 8 errors. Was this caused by fatigue? On the fourth day, his time was 72 seconds with 3 errors on the first trial, and 37 seconds with 4 errors on the second trial.

The reaction of the two year old group to the mirror part of the experiment was uniform, but surprising differences developed in the direct vision part of the test. Four of the ten two year old subjects could not, or would not, do even the direct vision part of the experiment. They seemed not to understand what was wanted, and just pushed the cannon aimlessly back and forth without regard to the path. Although they were given a second trial on the second day, they again failed completely. These four subjects were S, V, U, and X, among the youngest children in the group, X being the youngest. But W, the next to youngest made a perfect record in 8 seconds with direct vision. He was hopelessly lost, however, with the mirror and just pushed the cannon back and forth, back and forth till the time was up.

The six subjects who succeeded in the direct vision trial were given two trials with the mirror, one right after the direct vision and one on the next experimenting day. As they showed no change in behavior whatever, unless perhaps more boredom and tendency to play on the second day than on the first, they were not given any further tests.

Summary

This experiment is interesting not only as showing up clearly the mirror adaptability of different age groups but also the cleavage between the two and three year old performance in other test situations, i.e., the failure of nearly half of the two year olds to do the direct vision part of the experiment. The increased difficulty of this experiment also brought out strongly the emotion connected with the effort to learn the new hand and eye coördinations.

SUMMARY AND CONCLUSIONS

In order to ascertain whether very young children could learn new eye and hand coördinations three experiments were devised. First, a simple task of picking objects up and putting them in a cup, the cup and objects being visible only in a mirror; second, an experiment with foot movements in which the subjects pushed a disc with their foot from one position to another, foot, disc, and goal seen only in a mirror; and third, an experiment in which the subjects pushed a toy cannon along a path guided by the pattern seen in a mirror. In the second and third experiments, a pencil mark was left by the disc and cannon showing the course pursued on the way to the goal.

The subjects ranged in age from two to five years and were divided into three age groups, two, three, and four year old groups. There were 27 children in the first experiment and 22 in the second and third experiments. There were more boys than girls.

All three experiments show definite learning, and all three experiments show clear age differences, these differences becoming more marked as the difficulty of the experiments increases. All the subjects completed the first experiment, all the four year olds completed the second experiment as did all but one in each of the other age groups. None of the two year olds completed the third experiment. Only half of the three year olds but all of the four year old group finished the third experiment.

Conclusions

The results of the three experiments used in this investigation are so definite and clear cut that in spite of the few subjects used certain conclusions seem justifiable. Children as young as two years acquire skill in tasks requiring new hand and eye coördinations in movements that are in opposition to those demanded in the ordinary environment. Young children learn such new habits more slowly than do adults, and learning proceeds more rapidly and more accurately as age increases. Age differences in adaptation to such situations as the mirror experiments present, are closely related to the complication or increasing difficulty of the coördinations involved. Mirror experiments bring out emotional tendencies in children that merit consideration in the guidance of the child.

REFERENCES

(1) Bray, C. W.: Transfer of learning. J. Exper. Psychol., 1928, **11**, 443–467.

(2) Burt, C.: Experimental tests of general intelligence. Brit. J. Psychol., 1909-10, **3**, 94–177.

(3) Carmichel, L.: The history of mirror-drawing as a laboratory method. Ped. Sem. & J. Genet. Psychol., 1927, **34**, 90-91.

(4) Clinton, R. J.: Nature of mirror-drawing ability: norms for mirror drawing for white children by age and sex. J. Educ. Psychol., 1930, **21**, 221–228.

(5) Cooke, F.: A note on mental tests. J. Appl. Psychol., 1918, **2**, 378.

(6) Dearborn, W. F.: Experiments in learning. J. Educ. Psychol., 1910. **1**, 373-388.

(7) Henri, Victor: Ueber die Raumwahrnehmungen des Tastsinnes. Berlin, 1898, 130–141.

(8) Henri, Victor: Revue general sur le sens musculaire. Annee psychol., 1898, **5**, 503–508.

(9) Hill, D. S.: Class and practice experiments upon the learning process. Psychol. Bull., 1911, **8**, 70–71.

(10) Hill, D. S.: Minor studies in learning and relearning. J. Educ. Psychol., 1914, **5**, 375–383.

(11) Pyle, W. H.: Nature and develop-

ment of learning capacity, 1923, 48–53.

(12) SNODDY, G. S.: An experimental analysis of a case of trial and error learning. Psychol. Monog. 1920, No. 124.

(13) STARCH, D. A.: A demonstration of the trial and error method of learning. Psychol. Bull., 1910, 7, 20–23.

(14) WEIDENSALL, J.: The mentality of the criminal woman. Educ. Psychol. Monog., 1916, 14, 222–227.

(15) WELLS, G. B.: An apparatus for the mirror-drawing test. J. Educ. Psychol., 1918, 9, 99–101.

(16) WHIPPLE, G. H.: Manual of mental and physical tests, 1921, 120 (480)–123 (480).

Brief Reports

A Correction

IN THE issue of CHILD DEVELOPMENT for December, 1930, a brief report on Skill in Progressive Movements of Children by Johnson and Courtney included a table for results from the Walking Board Test. Due to the omission of a few decimal points the total scores and averages for longest distance walked are incorrect. The correct tabulation should be as shown in table I.

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TABLE I
Walking board

CASE NUMBER	CHRONOLOGICAL AGE		LONGEST DISTANCE							
	Years	Months	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
			inches	*inches*	*inches*	*inches*	*inches*	*inches*	*inches*	*inches*
1	4	8	30	55	35	35	25	40	115	60
2	4		90	135	60	85				
3	4	5	105	55	65					
4	4	4	75	32.5	135	135				
5	4	5	95	135	90					
6	4	10	117.5	80	67.5	57.5				
7	4	5	135	50	95	120				
8	4	8	135	67.5	27.5	50				
9	3	7	45	20	35	25	25			
10	4	4	22.5	27.5	35					
11	4	0	135	90	135	135	110			
12	3	9	47.5	70	40					
13	4	10	70	65	75	70				
14	4		40	25	55					
15	3	11	20	30	40					
16	4	1	35	25	55					
17	5	1	85	135	80					
18	4	3	60	85	75					
19	3	2	15	80	20	50	40			
20	2	8								
21	3		5							
22	2	7								
23	4	3								
24	3	4	50	40						
25	3	7	40							
Total			1,452.5	1,302.5	1,220.0	762.5	200			
Average			60.02	65.13	64.2	76.25	50			

Temperature Variations in Normal Pre-School Children

WHAT variations in body temperature are normal in healthy pre-school children? This problem was studied among a group of nursery school children at the University of California Institute of Child Welfare. Daily rectal temperatures were recorded at 9:00 a.m., 11:00 a.m., and at 1:00 p.m. until at least five records were obtained for every child at each period. It was first determined on a small number of cases that averages of five readings as compared with averages of ten readings were reliable and sufficient for our purposes. Eighteen children from 20 to 52 months of age were systematically studied in this way. The nursery school group included only normal, healthy children. This was determined at the time of application for admission, on the basis of information concerning such health items as: height and weight, disease history, frequency of colds and digestive disturbances, and the like. Daily medical inspection excluded all children suffering from acute infections, such as colds, and a complete medical examination at least twice a year served to check up on the general physical condition of the children. As an indication of the normality of the group, no child was more than 3½ pounds underweight during the period of this study. Additional records were obtained on 7 children after active play in sun suits at 11:00 a.m., and at 3:00 p.m. after a nap. The conditions under which sunbaths were taken were not sufficiently uniform to warrant presenting the data in detail.

From these records it has been possible to obtain data concerning: (1) characteristic temperature fluctuations for individual children, and (2) average temperature variations for the group in relation to time of day, sex, age, and activity.

PROCEDURE

The first temperatures were taken at nine o'clock each morning, after health inspection. A certified clinical thermometer of standard make was inserted into the rectum approximately three centimeters, so that the bulb was well covered. Care was taken to insert the thermometer deep enough so that it could not be affected by outside air, and to insert it the same length each time so as to obtain comparable results. According to Benedict and Slack (1), the rectal temperature rises as the distance from the outside increases, until the highest point is reached at the depth of 6 or 7 centimeters, but the curves for temperatures taken at different distances are parallel. The same procedure was repeated at 11:00 a.m., 1:00 p.m., and 3:00 p.m.

RESULTS

Averages and average deviations

The average for the total series of records is 99.5°F. There were no differences in the average for boys as compared with girls, nor for the younger as compared with the older children, although the group average is distinctly higher than the rectal temperature which Howell (2) reports as normal for healthy adults, (98.96). In comparing the average temperatures on different days of the week, the slight differences found were unreliable.

In this group of apparently healthy children the lowest temperature recorded was 97.7, taken at 3:00 p.m. after a nap. The highest temperature, taken after a sunbath, was 101.7. Considering only the temperatures taken under the usual conditions at 9:00 a.m., 11:00 a.m., and 1:00 p.m.; the lowest was 98.0 and the highest 101.0. All children showed fluctuations in temperature from day to day. The lowest average deviation was .072 (five readings, at 9:00 a.m.) and the highest .664 (five readings at 11:00 a.m.).

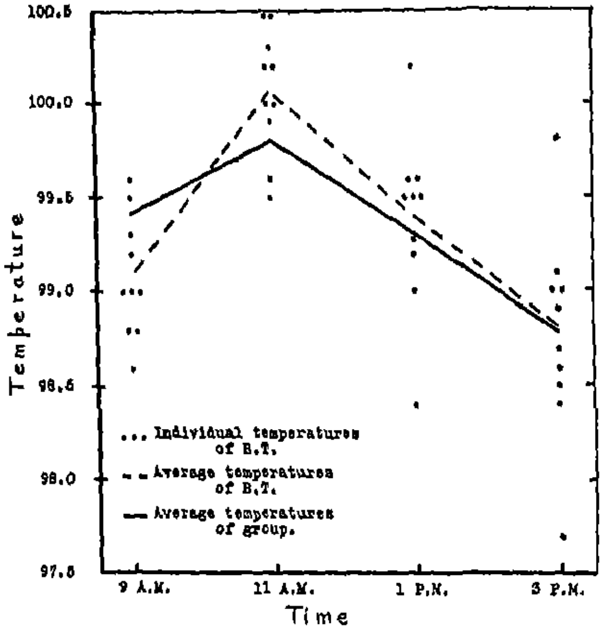

FIG. 1. FLUCTUATION OF RECTAL TEMPERATURES OF B. T. AT VARIOUS TIMES OF DAY

It was found that we not only had individual differences in regard to the amount of fluctuation in temperature readings, but that we also had some individuals whose temperatures registered consistently higher or lower than the average. One child had an average of all temperatures as high as 100.0, and another as low as 99.2. Fig. 1 illustrates the temperature fluctuations for a child whose temperature showed about average variability as compared with the group. Fig. 2 shows the temperature curve for L. J., whose temperature ran high consistently, and for E. T., whose temperature was low consistently.

Although children showing the greatest variations from the norm may have had some physical complication which did not show up in the physical examinations given at the nursery school, it is very unlikely that every temperature of 100 indicated illness. Every child in our group had at least one temperature of 100 or over at 11:00 a.m. Over half had a temperature of at least 100 at 9:00 a.m., with no obvious indications of ill health.

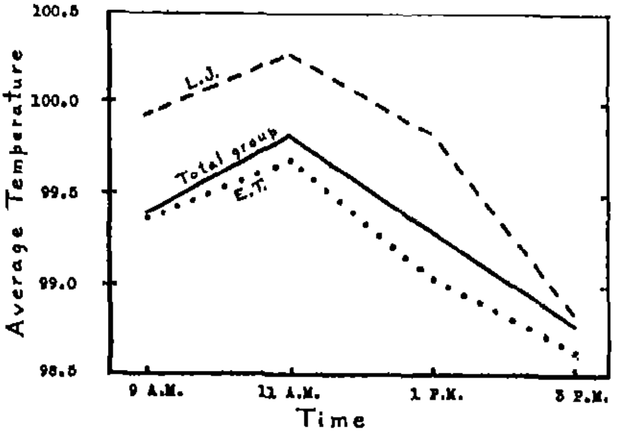

FIG. 2. AVERAGE TEMPERATURE CURVES OF L. J. (CONSISTENTLY HIGH), OF E. T. (CONSISTENTLY LOW), AND OF TOTAL GROUP

By compiling the data for the group as a whole further results were obtained as shown in table 1. The A.D. is here used to signify the average deviation from the mean of the average temperature for each child. At 9:00 a.m., approximately 50 per cent of the children yield average temperatures falling between 99.2 and 99.6. At 3:00 p.m., the middle 50 per cent of the children have averages between 98.6 and 98.9.

TABLE 1

Temperature variations in relation to the time of day

	NUMBER OF CASES	MEAN TEMPERATURE	A.D.
9:00 a.m.	18	99.395	.219
11:00 a.m.	18	99.83	.193
1:00 p.m.	18	99.31	.153
Average of 9:00 a.m., 11:00 a.m. and 1:00 p.m. temperature	18	99.51	.153
3:00 p.m.	7*	98.78	.139

* This group of seven children had mean temperatures at 9:00 a.m., 11:00 a.m., and 1:00 p.m. that were the same, through the first decimal place, as those for the entire group of 18 children.

At 11:00 a.m., when the highest temperatures were recorded, the children were finishing an active two-hour play period out-of-doors; the findings agree with those of other writers (Abt, Benedict and Slack, Woodhead and Varrier-Jones) who have noted that muscular activity and bodily exertion promote a rise in temperature. The 1:00 p.m. temperatures, which were lower, followed a period of relative quiet. The children washed for lunch, rested on cots for 15 minutes, and ate lunch in a leisurely fashion. Woodhead and Varrier-Jones (3) have reported that digestion of food is responsible for a rise in temperature, but that there is a slight drop immediately after eating and before the rise begins.

From 1:00 until 3:00 p.m. the children rested on cots in quiet, airy, rooms. All but one or two of the oldest children slept for most of the period. It was just after this rest period that the lowest temperatures were recorded. Although it is the general opinion that temperatures tend to be highest in the late afternoon, the effect of the rest period apparently offset this tendency, at least temporarily. There was no opportunity to record temperatures at a later hour as the children were called for and taken home shortly after their naps.

CONCLUSIONS

This brief study of temperatures in normal children shows the daily variability in temperatures, and the individual tendencies of children to depart from the average. It is well to remember that each child has his own range of temperature, and that muscular activity, food, and clothing must be taken into consideration in determining the importance of variations. The chart of a child's "normal" temperatures, taken at a nursery school, should be of some value in interpreting the significance of temperatures registered during illness, or during a suspected incubation period.

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Herbert R. Stolz, M.D.

REFERENCES

(1) Benedict, F. G. and Slack, E. P.: A comparative study of temperature fluctuations in different parts of the human body. Carnegie Institution of Washington, no. 155.

(2) Howell, W. H.: Textbook of physiology. 10th edition. p. 980.

(3) Woodhead, G. S. and Varrier-Jones, P. C.: Temperature records in normal individuals. The Lancet, 1916, 190, 1, 450.

Laughter in the Pre-School Child

PROBLEM

A STUDY of laughter in children of pre-school age was made in order to contribute, if possible, to the solution of the following questions:

1. What are the causes of laughter in children of pre-school age?
2. Do the causes of laughter vary with age?
3. Does the occurrence of laughter vary with
   a. Age?
   b. Social contact?
   c. Intelligence?

METHOD

1. From February to June 1931, record was kept of laughter on the part of the children enrolled in the Nursery School of Vassar College. These observations were made for an hour at a time at five different periods during the week. It must be borne in mind that the results are based upon observations made at different periods during the day and are in no sense a complete record of the incidence of laughter throughout the period of study.

2. Four toys were exhibited to the children individually and in groups. The toys were placed under a cover which each child was allowed to remove for himself and discover what was underneath the cover. The reactions of the children to these toys were noted. The toys were: (a) A spotted dog with movable ears and tail; (b) a spotted rubber dog who squeaked and whose head and tail were moveable; (c) a clown with a fur body hung on an elastic string; (d) a jumping jack.

RESULTS

1. Observation in the nursery school

From direct observation, the observer found that the incidence of laughter noted fell under the following headings:

a. Motions made by the child himself, by other, or by objects.

b. Noises made by the child himself, by others, or by objects.

c. Socially unacceptable situations.

d. Grimaces made by child himself or by others.

e. Inferiority in others.

f. Pleasure of child in occupation or accomplishment.

g. Situations showing appreciation of humor.

h. Word play.

i. Imitative laughter.

j. Situations involving make-believe.

k. General well-being and happiness.

2. Presentation of toys

On the whole, the experiment of showing the four toys to the children was not very successful in causing laughter. Interest and curiosity, rather than amusement, were shown by nearly all of the children. When summarized, these results show that out of 100 possibilities for laughter, only 12 real laughs occurred, while there were a 9 laughs or snickers, and 60 smiles.

As a test of the social element in laughter, these toys were presented to groups of the children. There was not any marked increase in the laughter caused. All of Group I smiled at each of the toys, but none really laughed. In Group II, one laughed heartily, although she had not laughed at all when the toys were presented to her alone. In Group III only one child laughed and her laugh was rather one of excitement than amusement. One child in Group III laughed at the very beginning seemingly in anticipation; one smiled, and one laughed heartily at all of the toys. He also had not really laughed when the toys were presented to him alone.

Results from the direct observations, however, seem to show that children very seldom laugh except when in the presence of others. Out of the 223 situations in which laughter was noted, only 14, or 6.3 per cent occurred when the child was alone.

3. Laughter and intelligence

Of the 16 cases including Intelligence Quotients ranging from 100 to 130, the average was 118.06 and the average number of laughs, four and seven tenths

There were 10 cases of intelligence that were markedly above the average. The average Intelligence Quotient of this group was 140.6 and the average number of laughs, thirteen.

CONCLUSIONS

1. The children of pre-school age studied in this paper laughed most frequently at situations which involved motion of self; second, at situations which they realized were socially unacceptable; and third, at humorous situations.

2. The laughter of the two-year-olds was caused most by motion of self; next by socially unacceptable situations; and third, by pleasure in occupation and accomplishment. The three-year-old group laughed most frequently at the socially unacceptable situations; next at situations involving make-believe; third, at situations showing appreciation of humor; and fourth, motion of self. The laughter of the four-year-old group was caused most frequently by motion of self; next by situations socially unacceptable; third at those showing appreciation of humor.

3. In the two-year-old group, for the period studied, the average number of laughs for each child was fourteen; in the three-year-old group the average was six and two tenths; and in the four-year-old group the average was six and five tenths.

The presence of other children does, for the most part seem to be an essential element in the occurrence of laughter in children. That is, children seem to laugh very seldom alone, although the mere presence of other children does not necessarily mean that there will be increased laughter.

The results from the group of children studied seem to show that there is some correlation between the amount of laughter and the intelligence of the child; those having a higher I.Q. laughing more frequently.

MARGARET KENDERDINE.

A Study of Fifty Home Libraries with Special Reference to Their Function in Child Development

THE investigation which is described in this paper consisted of quantitative and qualitative appraisal of 50 home libraries with special reference to their function in child development. The data for the study were gained through interviews with the mothers in their homes and through actual examination of the reading materials found in each family library. Morris, Illinois, a city with a population of 6,000 was chosen as the location of the survey. A total of 162 children was found in the 50 homes, ranging from homes with an "only child" to homes with as many as 10 children. The average number per family was three.

Of the 50 homes visited, 38 were found in which both parents were native-born, 8 in which both were foreign-born, and four in which one was foreign-born and one native-born. There were wide variations in the occupational classification of the fathers. Using Taussig's classification, 32 per. cent of the fathers may be classified as unskilled laborers, 18 per cent as skilled laborers, 32 per cent as business men, and 18 per cent as professional men. The educational status of the parents presented further variation. Of the parents interviewed, 8 per cent had not finished grammar school, 38 per cent had completed the grades, 8 per cent had not finished high school, 24 per cent had graduated from high school, 4 per cent had not finished college, and 18 per cent had graduated from college. In addition, 18 per cent of the fathers had received professional training, as medicine, law or theology.

It is thus evident that there was great variation in the nativity of parents, occupational classification, educational status, and size of family in the 50 homes studied. It is believed that a fair cross-section of the community was secured. The occupational and nationality distribution of this sampling corresponds very closely to the 1931 government figures for the city as a whole, furnished by Leon E. Truesdell, chief statistician for population.

Records were made of the total number of books, magazines, and newspapers, as well as lists of the titles of children's books and magazines and child study books and magazines found in each home. The average number of newspapers was two subscriptions per family. The most common dailies were the local paper, *The Morris Herald,* and *The Chicago Tribune.* The average number of magazine subscriptions per family was five. The most common magazines were *Good Housekeeping, Ladies' Home Journal, Saturday Evening Post, Womans' World, The Literary Digest, National Geographic,* and *The Parents' Magazine.*

Inasmuch as the special interest of the investigation was in regard to the home library as an agency of child development the number of children's magazines is of special significance. An average of one subscription per family was found. The most popular children's magazines were *Child Life, American Boy, Young Crusader, Junior Home,* and *Youth's Companion.* In regard to child study magazines, an average of less than one subscription per family was found. The two most common child study magazines were *The Parents' Magazine,* and *Child Study Magazine.*

A total of 150 books was found to be the average number per home. An average of 22 children's books per family was found. The five children's books found most frequently were Andersen's Fairy Tales, Stevenson'sTreasure Island, Barrie's Peter Pan, Sewell's Black Beauty, and Spyri's Heidi. The ten most common children's authors were Perkins, Twain, Anderson, Alcott, Kipling, Stevenson, Spyri, Hurlbut, Barrie, and Sewell. In regard to books on the subject of child development an average was found of two books per family. The most common titles were: Galloway—Parents and the Character Training of Children, Waddle—Introduction to Child Psychology, Gruenberg—Guidance of Childhood and Youth, and Tanner—The Child. Over half of the child study books owned in these homes were popular rather than scientific.

This statement is not meant to disparage material written in a popular manner. It is of importance, however, that the facts and principles given be accurate. The four titles which were most frequently found are standard volumes in child study, but these titles represent only a small proportion of the total child study books owned in the homes. Over half of the books were titles found in only one home each.

The mass of data may be viewed from several angles other than group averages and frequencies. Tabulations were made of the results according to nativity of parents, occupational class, educational status, and number of children in family. Because of the small number of cases in the groups as well as the small size of the means in general, the averages are to be interpreted only as indicating possible tendencies. There is no assurance whatever that the differences between groups are in any way significant. When the 50 homes were grouped according to occupational class there was an increase in the size and quality of the home library which paralleled the rise in socio-economic status. When the homes were classified according to educational status of parents there was a general increase in the size of the home library along with increased educational opportunity, and a uniform improvement in the quality of the reading materials. When the homes were grouped according to nativity of parents there was no significant difference in the size or quality of the libraries of the different groups. When the homes were classified according to number of children in family there was no evident increase or decrease in proportion to the size of the family, although families with few children showed higher averages than those with from six to ten children.

We have already stated that the home libraries were judged qualitatively as well as quantitatively. The problem was to find a measuring stick by which to evaluate the children's books found in the homes. This required a review and careful analysis of the literature in the field of children's reading. After reviewing all available research in the field the following criteria were formulated:

1. The books should possess literary merit.
2. The books should have personality-orientation value.
3. The books should possess interest value for children.
4. The books should be adapted to the age and reading ability of the child who uses them.
5. The physical make-up of the books should be attractive to children and in harmony with hygienic requirements of printed materials.

More difficult than formulating the standards was the problem of finding objective judgments on the worth of specific books. After carefully studying the methods used in the compilation of 28 book lists, the "Winnetka Graded Book List" and "A Guide to Books for Character" (the Iowa Institute of Character Research study) were selected as the lists to be used in evaluating the fifty home libraries. These two lists were equated on a sigma unit scale and numerical scores were assigned for literary merit and personality orientation value, and interest value for boys and for girls.

The literary merit of the children's books found in these homes was very low as measured by the criteria established in this study. In these homes children's books seem to have been selected on the basis of interest rather than literary merit and personality-orientation value. The interest value of the books was high both for boys and for girls. In regard to the age and grade suitability of the books found in these homes, the general tendency seems to have been to accumulate books with little regard to their suitability for the children of a given home. This is shown by the fact that in many homes practically all the books were adapted to one or two age-levels. Hence some children had an abundance of appropriate reading material, whereas other children in the same family had no suitable material.

In the homes included in this survey the size of the home library appears to be decreasing. This statement is based on the testimony of mothers that crowded living conditions and frequent moving make the ownership of large libraries impossible, even where the cost of books is not an important economic factor. The general trend is to substitute newspaper and magazine material for books. The lower cost and easy means of disposal when read were reported the important factors in this change.

Growing out of this study are several suggestions for those outlining the progress of child study in the home. Present knowledge concerning children's reading interests and needs might well be incorporated in the curricula of child study groups. At present in many localities the emphasis seems to be largely on the physical welfare of the child. Attention could well be directed to subjects such as providing adequate reading facilities for children in the home.

There is a definite need, at least in the locality in which this survey was made, for a parents free book review service which would give critical evaluations of children's books and help to counteract the effects of high-powered salesmanship in the field of children's books. The mothers interviewed stated that they had no means of knowing what books to buy except as they accepted the recommendations of book agents.

There also seems to be urgent need for the re-writing of child study materials for various levels of educational background. Much of the authentic child study material which is at present recommended to parents is written in a technical manner which presupposes college training. Parents who have not had such training reported that they find these books practically useless, and if interested must rely on popularly written material which is often unscientific.

GERTRUDE HILL NYSTROM.

Some Factors Affecting the Night Sleep of Children

RECORDS of the night sleep of 34 pre-school children were obtained from parents of the Washington Child Research Center for a period of 30 days. Each parent observed and recorded the time the child went to bed, went to sleep and awakened. There were 15 two-year-olds, 14 three-year-olds, and 5 four-year-olds.

TABLE 1

Night sleep of 34 pre-school children

AGE	TIME IN BED		TIME ASLEEP		TIME AWAKE	
	Average	S.D.	Average	S.D.	Average	S.D.
years		*minutes*		*minutes*		*minutes*
2	7:24 p.m.	23	7:51 p.m.	26	6:58 a.m.	24
3	7:38 p.m.	19	7:58 p.m.	20	6:46 a.m.	20
4	7:31 p.m.	14	7:51 p.m.	24	6:54 a.m.	27
All ages	7:31 p.m.	19	7:53 p.m.	23	6:53 a.m.	23

TABLE 2

Variables of night sleep

RANK ORDER CORRELATIONS	2-YEAR OLDS*	3-YEAR OLDS†	4-YEAR OLDS‡
Time of going to bed—length of time required to go to sleep	−.60	−.02	−.43
Time of going to bed—total length of sleep	−.96	−.47	−.03
Time of going to sleep—total length of sleep	−.88	−.56	−.10

* Correlations based on 450 records on 15 children.

† Correlations based on 420 records on 14 children.

‡ Correlations based on 120 records on 5 children.

Analysis of 1020 records (30 for each child) showed only slight differences between the three age groups in the average time the children went to bed, went to sleep, and awoke.

It was found that the average length of the night's sleep of the 3 groups was nearly equal. The two and three-year-olds slept 11 hours and 6 minutes, while the four-year-olds slept 11 hours and 2 minutes. Apparently the length of the night sleep of the children did not decrease with increasing age.

It was thought that the two-year-old children would go to sleep much quicker than three or four-year-olds. The reverse was true, for the three and four-year-olds were asleep on the average in 20 minutes, while the two-year-olds took 27 minutes.

The results of 3 rank-order correlations may be seen in table 2. These correlations indicate that the later the children were put to bed the longer it took them to go to sleep, and the later they awoke in the morning. However, their total length of sleep was shorter than that of children who went to bed earlier. The rank-order correlations between length of sleep and intelligence quotient were as follows: two-year-olds −.43, three-year-olds −.27, four-year-olds −.20. These correlations indicate that children with higher intelligence quotients got less sleep than children with lower intelligence quotients.

MARGARET RICHIE WHITE.

An Audiometric Test for Young Children

Harold M. Williams[1]

As yet no adequate test of auditory acuity has been developed for use with young children. A satisfactory test for this purpose demands, in addition to the more general requirements of validity and exact control over the physical intensity of the stimulus, extreme simplicity of task, adequate motivation, and objectivity in the response required of the child. The whispering tests, while they represent a relatively valid measure of the actual functional efficiency of the ear, are lacking in control over the physical loudness of the sounds to such an extent that it is impossible to construct norms for the method, or to compare the work of different experimenters. The pure-tone tests, on the other hand, while they possess a high degree of control over the physical intensity of the sounds, are quite unsuitable for use with young children, on account of the intrinsically uninteresting character of the test, and the uncertainty of interpretation of the child's response.

The development of the Western Electric 4-A audiometer (1) has provided a technique which combines the advantages of both types of test in a unique way. In this audiometer spoken numbers have been recorded at standard intensities on a phonograph disc, from which the sounds are picked up and transmitted electrically to a telephone receiver held to the ear. Relatively valid test sounds are therefore delivered to the ear under excellent conditions of physical control.

By the introduction of certain modifications of procedure in this technique, it is believed that the requirements outlined above for audiometric tests of young children have been successfully met.[2]

The test, which is necessarily given individually, has been converted into a "listening over the telephone" game. This change results in setting up a novel game situation which is easily grasped by the child and is well motivated. The first eight digits (the number seven being omitted) are used as test words. These are spoken singly, with an interval of four seconds between each number during which the child reports the number heard to the tester, who decides the correctness by an auxiliary receiver. The numbers are recorded on the disc in a series of twelve levels descending in loudness, with two consecutive numbers at each level. The numbers in the first half of the test are spoken by a woman.

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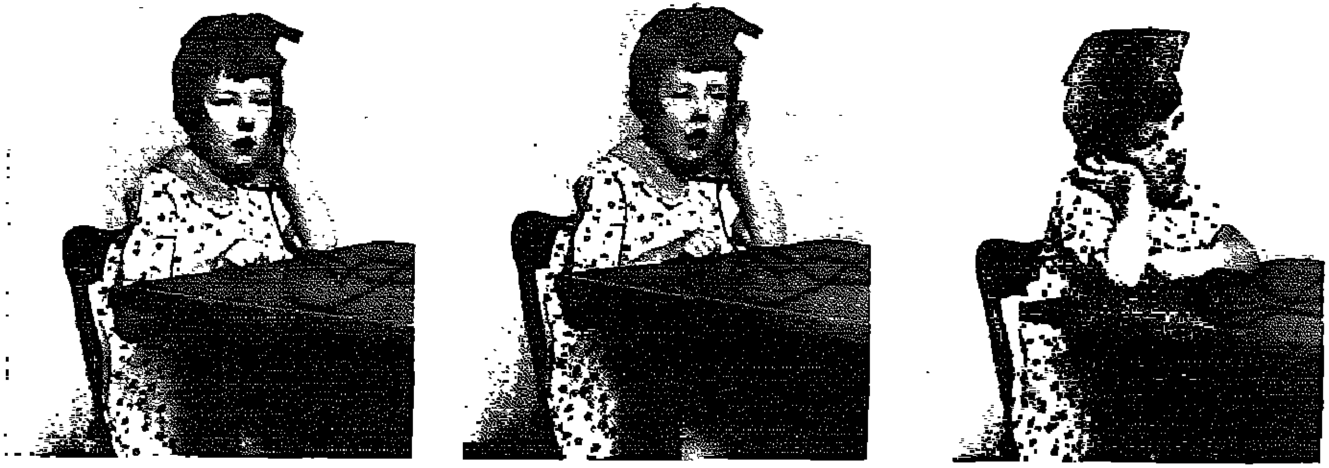
[1] The experimentation reported here was carried on while the writer was a National Research Council Fellow in Child Development at the Iowa Child Welfare Research Station.

[2] These modifications were incorporated in new phonograph records specially made through the courtesy of Dr. Harvey Fletcher of the Bell Telephone Laboratories, to whom grateful acknowledgment is made.

In the first trial record the directions were incorporated in the record. Further trial showed, however, that these directions were confusing to the younger children, so that they are now given by the tester. The preliminary directions are as follows: "I want to find out how well you can hear, so we are going to play a 'listening over the telephone' game. When you put this telephone receiver to your ear you will hear a lady saying some numbers. You are to listen carefully and tell me each time what she says. Ready!" The right ear is tested first. The first four numbers on the record are all of the maximum loudness and are used as a trial series to make sure that the child understands the directions and is responding satisfactorily. At the same time the tester makes the proper adjustments of the receiver to the ear. After the preliminary adjustments are made the tester now says, "Now you will hear some more numbers, but this time the lady's voice will get weaker and weaker. You must listen carefully so that you can tell me each number." The record is then run through until the child fails to report at least four consecutive numbers successfully. The directions then are, "Now we will try the left ear in just the same way as we tried the right ear." The inner half of the disc presents a similar series for use with the left ear. The obverse side of the record presents a similar series, spoken by a man.

Numbers were chosen as test materials after careful consideration of the situation for the following reasons. Children learn very easily to manipulate the first eight or more number names, even though the numbers as quantitative concepts may be quite meaningless to them. Even the three-year-old children tested showed no traces of unfamiliarity with the number names as words, although relatively few of them could count to eight independently. The Stanford Revision of the Binet scale (2) puts the repetition of three digits in the three year level, so that it is quite unlikely that the repetition of a single digit is in any way a task for the intelligence of the average child of this age. The narrowing of the field of choice to seven numbers makes the task of interpreting and recording the child's responses much simpler than if the words were chosen from the general field of common words, while still keeping the probability low that any child will get any number correct by chance.

While a spring support to hold the receiver against the ear would insure the greatest constancy of pressure, an actual tryout of such devices indicated that with many children they were a source of such great distraction and irritation that the test results were entirely invalidated. At present, therefore, the child is merely instructed to hold the receiver closely against his ear, the experimenter taking care to see that the hair is brushed well back, and that the receiver is held by the child with the opening of the cap directly opposite the meatus. Practically all the children tested



1a 1b 1c

FIG. 1 In a the numbers are clearly perceptible, in b fairly perceptible and in c they are completely below the threshold.

tended to press the receiver quite closely against the ear as the sounds became fainter.

The incidental remarks of the children tested have shown as a whole that they appreciated the situation and were entering into the spirit of the game. Such comments as, "Oh, her voice just gets so soft," were common. Nearly all of the children spontaneously remarked near the end of a series, "I can't hear her any more." Others, after listening intently said, "Why doesn't she say any more numbers?" The attitude in general, changed from one of great confidence and certainty, to one of increasingly greater uncertainty as the sounds became weaker. The new rush of interest which appeared when the man's voice was announced was an unexpectedly successful feature of the test. Illustrations of the motivation value of the test and of the change in attitude as the sounds became weaker are shown in the photographs in fig. 1, taken as the child was being given the test.

The tests are scored in terms of sensation units of hearing loss as is done with the former records. The test results are recorded on a blank form having divisions from 30 sensation units hearing loss to −3 units. On each level there will be 4 numbers for each ear. Due to the fact that lapses of attention, over-eagerness to make some remark about the "game" and so on are of common occurrence, many gaps will appear in the record of most children. For this reason considerable latitude must be allowed in the interpretation of the results, especially in the case of the younger children. The hearing level is therefore defined tentatively as the lowest level at which each child has 50 per cent of right responses.

The reliability of the test on 57 children, of age range four and one-half to six and one-half years, was .697, P.E. .05 by the method of chance halves. This would yield a reliability of .82 for the whole test. In ordinary routine testing, therefore, one application of the whole test is probably adequate for gross differentiation between normal and defective. The defective may be more intensively tested by repeating the record.

TABLE 1

Distribution of scores on audiometer test

HEARING LOSS	AGE							
	3-4 Years		4-5 Years		5-6 Years		6-7 Years	
	Right	Left	Right	Left	Right	Left	Right	Left
	Number of cases							
30								
27				1				
24	1	1						
21	1		1	2				
18	3		7	1	4			
15	2	2	3	4	2		1	
12	7	10	1	3	1	5		1
9	2	2	16	3	12	8	1	
6		1	5	10	11	6	12	2
3			2	9	1	11	3	11
0				2	1	4	2	4
−3					3	1	3	4
Number..	16		35		35		22	

Table 1 summarizes the results by the scoring method recommended above on 108 children of age ranges, 3-4, 4-5, 5-6, and 6-7, from the preschool laboratories of the Iowa Child Welfare Research Station and the first grade of the University Elementary School.

These children were all normal or superior in intelligence. It will be noted that there is an increase in score from age group to age group. This may be interpreted in part as an increase in attentional power, but it is possible that there is a real increase in acuity during these ages. A few of the scores indicate serious impairment. In at least three cases observational evidence corroborated the findings of the test, although previous to the test no defect was suspected.

Where the necessary apparatus is available the test may be given with a record of constant intensity, the experimenter varying the loudness by the attenuator of either the 2-A or 3-A Western Electric audiometer. A special record on which the numbers are all of maximal intensity is also available. This method has the advantage of making it possible for the experimenter to work down quickly to the critical level for each child, and to concentrate his efforts there. In the hands of a skillful tester who understands children it is believed that either technique will yield results which are far superior to current methods of testing acuity of very young children. Where the 4-A audiometer is already available the only additional expense which must be incurred is for the new phonograph records.

REFERENCES

(1) FLETCHER, HARVEY: Some new methods and apparatus for testing acuity of hearing and their relation to the speech and tuning fork methods. Laryngoscope, 1925, 35, 501-524.

(2) TERMAN, LEWIS M.: The measurement of intelligence: An explanation of and a complete guide for the use of the Stanford revision and extension of the Binet-Simon intelligence scale. Boston, 1916, pp. xviii, 362.

A Study of Problem Solving Behavior in Pre-school Children[1]

EUNICE MATHESON

PROBLEM

THE present study is an attempt to observe and analyze the problem solving activities of young children placed in situations similar to those employed by Köhler (9) in the experiment reported in The Mentality of Apes. The purpose of the study is not to make direct comparisons between the behavior of children and apes, nor to deal with the theoretical implications of gestalt psychology, but to get a general picture of the solving type of behavior in very young children by using Köhler's method of arousing activity of this kind.

History

In The Mentality of Apes, Köhler states the essential feature of his method by contrasting it with the maze experiment. He says, "American animal psychology makes animals (or people) seek the way out of mazes, over the whole of which there is no general survey from any point inside; the first time they get out is, therefore, necessarily a matter of chance, and so for these scientists, the chief question is how experiences which have been made in such circumstances can be applied in further tests. In intelligence tests of the nature of our roundabout-way experiments, everything depends upon the situation being surveyable to the subject." He goes on, "Regarding their principle, I must make a further objection to Thorndike's experiments. They were designed as *intelligence tests* of the same type as our own (insight or not?), and ought, therefore, to have conformed to the same general conditions, and, above all, to have been arranged so as to be completely visible to the animals. For if essential portions of the experimental apparatus cannot be seen by the animals, how can they use their intelligence faculties in tackling the situation?" Therefore, Köhler uses situations "in which all the factors were given and the solution could be achieved," not situations in which the individual was dealing with things "merely thought about."

Köhler, besides reporting in his book the results of his work with the apes at Tenerife, reports experiments on hens, a dog, and a small child in situations which demand a "roundabout way" of solution. In the first place Köhler was trying to determine the intelligence level of the subjects with which he was working. The second aim in his work, he says, is theoretical. The fact that even the anthropoid apes are such a long way behind man, and yet "show so many human traits, makes it possible for us to study, under the simplest conditions, the nature of acts of intelligence." And "one may be allowed the expectation," he says, "that in the intelligent performances of anthropoid apes we may see in their plastic state once more processes with which we have become so familiar that we can no longer immediately recognize their original form; but which because of their very simplicity, we should treat as the logical starting point of theoretical speculation."

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[1] From the Department of Psychology and the Institute of Child Welfare, the University of Minnesota. The study has profited much by many helpful suggestions given by Dr. Edna F. Heidbreder, Dr. John E. Anderson, Dr. William T. Heron and Dr. Florence L. Goodenough. Thanks are also due the children of the Nursery School who acted as subjects in this experiment, and the principal, Dr. Josephine Curtis Foster, and teachers of the Nursery School for their cooperation.

Köhler's principal conclusion was that the apes manifested "intelligent behavior of the general kind familiar in human beings," i.e., they were not limited to trial and error in dealing with problems. He reported that they sometimes displayed a type of behavior which he called "insight." He gave three criteria of insight, which may be stated in the form of questions: Is the achievement a single continuous occurrence,—a unity as it were in space and time, in which the individual parts have meaning only when considered in relation to the whole? Is the instant sharply marked in which the real solution begins by a kind of jerk, a sudden complete turning about, or a lighting up of the face of the subject? Is the animal able to repeat the solution when placed in a similar situation, if a genuine solution has previously been used? The presence of behavior characterized by insight brought his work into contrast with that of Thorndike (12), Watson (13), and other American animal psychologists, who explained animal learning in terms of trial and error as opposed to insight.

Köhler himself suggested that his methods might be used in studying the behavior of young children. Although this suggestion was made some years ago, there have been, up to the present time, very few studies of this type made on human beings although both before and after Köhler's suggestion, there were many attempts to study the thinking or problem solving ability of human beings. Very little of it, however, has been of the type in which the individual was placed in a situation for which all the necessary material for solving was present. Helseth (7) observed and recorded the behavior of a group of seventh and eighth grade students in a history class, and tried to study and work out the lines of development in their thought processes. This was, of course, an experimental study, and yet it has very little direct bearing on this other type of study, for the tool which the pupils were using in that experiment was language and things thought about, rather than objects actually present. Piaget (10) has also studied the thought processes of the child, but his studies concerned themselves with the thinking processes of the child in connection with social situations. Philosophers have long tried to work out logical analyses of the human thought processes, from the "recognition of the problem" to the consummation in "solution" and "verification." There are, however, a few studies in which human subjects have been placed in problem situations in which they were given the objective materials with which to work, and in which enough was explained so that they recognized the problem. Their behavior in the process of solution was then observed and studied. Studies of this sort have been made by Ruger (11), Heidbreder (7, 8, 9) and Duncker (2).

Comparative studies have also been made of the thought processes and concepts of primitive peoples and young children as opposed to those of civilized adults. Koffka (8) mentions the observations of Decroly and Degand, the Sterns, Major and Linder, and Wertheimer on this topic in his discussion of the dependence of thinking on the development of language.

Studies have also been made by Thorndike (12), Yerkes (14), Haggerty (3), and others, in which the behavior of animals has been studied in order to determine whether or not the term "insight" as used by Köhler may be applied to their reactions.

Two studies which have followed Köhler's suggestion very directly are those of Blatz and Alpert. Blatz has done some experimental work with young children, using situations as nearly similar as possible to those reported by Köhler. As yet only a preliminary survey has been published with regard to this work. Alpert (1), who placed children of the pre-school level in situations similar to ones used by Köhler comes to the following conclusions:

1. "Exploration and elimination" is the most frequent type of behavior with children and also yields the greatest number of solutions.
2. Solution with gradual insight is perhaps the most frequent type among apes, whereas immediate is the most frequent for children.
3. Chance alone is ineffectual in problem situations of this type, but it may be instrumental in bringing about an optimum constellation of the elements, which may or may not arouse insight, but response culminates in solution only if subject has gained insight.
4. Transfer and retention seem to be indices of presence and degree of insight.
5. There is a low correlation of .266 between M. A. and achievement.
6. A child's solving activity is determined more by the nature of the problem situation than any one other factor.
7. The arousal of insight and its consummation in a practical solution are favored by emotional, temperamental and mental factors, in short, those factors which go to make up the total personality of the individual.

The present experiment, then, is the third which attempts to study the behavior of young children who have been placed in situations similar to those which Köhler placed his apes.

Method

In the experimental set-up the situations were objectively as similar as possible, both in general arrangements and details, to certain ones used and described by Köhler. Preschool children, one by one, were placed in five selected situations, and the various types of reactions which were brought out were observed and recorded in an attempt to study the problem solving activity at this age.

Subjects. The subjects were 28 children attending the nursery school which is conducted by the Institute of Child Welfare at the University of Minnesota. Considered as of January 1, 1929, they ranged in age from two years to four years six months, the mean C.A. being 41.3 months. For the purpose of considering age differences, the children were divided into three groups. The youngest group includes only three children between two and two and a half years. The eleven children spoken of as three-year-olds, ranged from two and one-half years to three and one-half years; the four-year-old group, ranged from three and one-half years to four and one-half years, and included fourteen children.

The mean I.Q. of the group of twenty-seven children was 115.1, and the mean M.A. 48 months. All but one of the I.Q.'s are based on Minnesota tests for pre-school children. This one exception is based on a Stanford-Binet. No. I.Q. has been obtained on one of the youngest children because of negativism and lack of responsiveness. The sexes are about evently divided, but with relatively more boys in the upper age group. The children are selected for the nursery school so that the representation of the socio-economic classes is approximately the same as that in the population of the city at large.

General conditions. The experiment was conducted over a period of four months, beginning in January, 1929, and continuing through the month of April, 1929. The experiment was carried on between 2:30 and 3:45 in the afternoons. The children began waking from their naps at 2:00 or before, and no child was taken to the experimental room immediately upon awaking, but was allowed to enter group activity or into some individual activity before the experimenter suggested to him that he go upstairs for a while, where there was something for him, or where there was a game for him to play.

In all the situations the child was to try to get a cookie. Since it was thought that the mid-afternoon lunch of milk and wafers or crackers might reduce the motivating value of the animal cookie the child was allowed but one wafer at lunch. Except in a few instances, the children were ready and eager to go with the experimenter. Often, when the experimenter was calling a child, another would ask "May I go today?" or "I know what she has for you, an animal cookie," or "Oh, I know a cookie, a cookie." It seemed to the writer that some of the children who were least eager to go were the ones who had recognized their own failure in a previous situation. This is perhaps only a generalization from a few noted cases since records on this point were not kept.

As was stated, the situations used were as similar in objective details as possible with certain ones used and described by Köhler.

Situation I. This situation was similar to the one Köhler describes in his introduction. A medium-sized black ring (two and one-half inches in diameter) hung in the middle of the ceiling. Through this a red string was drawn, which suspended a basket containing an animal cookie. The basket was beyond the child's reach, at a distance of 5 feet 10 inches from the floor. The other end of the string was tied to a small black ring that was placed over a plain, right-angle hook, which was fastened in the wall two and one-half feet from the floor. The solution consisted in taking the ring off the hook and allowing the basket to fall to the floor, thus bringing the cookie within the child's reach. There was no other object in the room except a small box on which the experimenter sat while keeping the record.

Situation II. In this situation the basket hung from the middle of the ceiling at a distance of 5 feet 12 inches from the floor for all but the four smallest children, for whom it was lowered 4 inches. The string was fastened to the ring in the ceiling so that the basket could not be lowered. There were two boxes in the room, one against the right wall as the child entered the room and the other against the left. The box which was placed about half way along the right wall was 12 inches by 12 inches by 12 inches. The other was 12 inches by 16 inches by 20 inches. This situation was complicated, however, by placing the ring over the hook as in Situation I, but fastening the other end of the string to a small hook in the ceiling at a distance of 4 inches from the black ring from which the basket was suspended. This situation then, at the first glance, would appear somewhat similar to Situation I. The solution consisted in placing the smaller box on top of the larger one, climbing up and taking the cookie from the basket (9).

Situation III. For the next three situations, a railing 30 inches high, with spaces of 3½ inches between the rails, divided the room into two equal parts, into one of which the door of the room opened. The child remained in the outer part and the goal was placed beyond the railing. In this situation a small box with a picture of an animal on it was placed 36 inches from the railing and opposite the middle of it. The box contained the usual animal cookie. Fastened to the box was a red string. The other end of the string just touched the railing. There were also four other strings, each of which touched the railing. These were placed in such positions that the correct string at the railing was the middle one of the five. The strings were placed in such a position that two "X's" and one straight line was formed (9). The solution consisted in choosing the correct string and pulling the box to the railing, where the child could get the cookie.

Situation IV. In this situation the same box as in Situation III was placed in a similar position except that it was only 33 inches from the railing. The tools given for solution were three sticks, 30 inches, 31 inches, and 35 inches in length, any one of which was long enough to reach the box. The sticks were irregularly placed on the child's side of the railing near the right hand wall. This situation was complicated by having the space between the box and the railing covered by the five strings, placed as in Situation III except that the box was separated from the end of the string which had been the correct one in that Situation, by a distance of 3½ inches. The solution consisted in choosing any one of the sticks, putting it beyond the box and pulling the box to the railing, where the child could reach it and get the cookie.

Situation V. In this situation the box containing the cookie was placed at a distance of 33 inches from the railing near the right hand wall. A stick 14 inches long lay alongside the railing and opposite the box. Near the left wall, beyond the railing and out of reach of the children if they used their arms, a stick 35 inches long was placed parallel to the railing. The solution consisted in securing the long stick with the short stick and pulling the box to the railing as in Situation IV.

In all these situations an effort was made to have all the parts of the situation within the child's field of vision. This was particularly difficult with the young children, who, as Alpert says, often see only that which is on a level with their eyes, and do not look up nor down. Only with a few of the very small children was this difficulty found and in these cases the child was lifted by the experimenter until his eyes were on the level with the basket. Then he was put on the floor again and the routine procedure continued. It was thought better to lift the child up to the basket rather than to point to it, since the child might merely imitate the action. In most cases, however, the children saw the basket the moment they entered the room, or looked at it when the experimenter gave the first instruction.

Procedure. The cookie was placed in the basket or box before the child entered the room. Upon entering, the child was given the following instructions: "There's an animal cookie in the basket (or box) for you, (name sometimes mentioned here). You get it and you may have it." No further directions were given or questions asked, such as might in any way aid the child to a solution. Questions regarding manner of solution or asking for help were not answered. If the child asked for *permission to do a specific thing*, the answer was "Yes," or "You may get it in any way you wish." "You get it" was sometimes repeated in the beginning, in order to make sure the child had understood the first directions. When the child had not tried, or had tried but without success, the experimenter used as a means of regaining the child's attention to the situation, or a means of motivation, "Do you know that John and Polly Ann and Dickie were up and got their cookies? Now you get yours." Before each trial was brought to a close and usually at the end of about five minutes, if the attempts of the child had been without success, or if he had not tried at all, the experimenter asked, "Would you like to go downstairs, or do you want to have the cookie?"—always in this order, so that the final suggestion in the child's mind was the cookie and not the going downstairs. If the child said he wanted the cookie, the experimenter said, "All right, you get it," and if he made further attempts he was permitted to go on for a short time, after which the experimenter said, "I guess we'll go downstairs now and try another day. Then I think you can get it."

Records. Records were kept on

blanks which gave a place for the date, the name of the subject, the situation, the length of time the child remained in the situation, a space for a running account of what both the experimenter and the child said, and also for a description of the total activity of the child.

Since it was the purpose of the experiment to get a general picture of problem solving behavior in young children, the first step in the treatment of the results was to note all the different kinds of overt reactions that occurred. It was found that these fell into the following fifteen categories:

Kinds of reactions observed

1. *Failure to Respond:* A group composed of three sub-groups.
   a. *Not responding,* (N. R.)[1]—No response to the problem situation, either for the entire time or for part of the time.
      Examples: Subject looked at basket while first instructions were being given, but wanted to look at book.
      Subject went and played with door knob.
      Subject played with collar on dress; watched experimenter; then said, "I got a little dolly in my pocket."
   b. *Negativism,* (N.)—Cases characterized by stubborn unresponsiveness in behavior, lasting for a long enough period so that the records make the fact apparent.
      Examples: Subject merely stood and looked at experimenter and sucked fingers. Showed no response to instructions and did not answer the questions of the experimenter.
      Subject looked around room, eyes on the floor, and did not look up at the basket. Subject did not in any way recognize experimenter's questions or instructions.
   c. *Leave situation,* (L. S.)—Cases in which the child said he wanted to leave the room.
      Examples: Subject standing by door repeated several times, "I want to dŏ downstairs."
      Subject trying to open door, said, "I want to dō out. I want to dō out here. I want to dō out. Where's my toat?"
2. *Feeling of Incapacity,* (Inc.)—Cases in which the child expressed or indicated a feeling that he could not meet the situation.
   Examples: Subject went to railing, and at same time stepped on the sticks. He repeated, "I can't. I can't."
   Subject said, "I can't get it. See, I can't get in here."
3. *Asking Experimenter for Help,* (E.)—Cases in which the child sought the aid of the experimenter.
   Examples: Subject said, "Can I get a stick? Will you get the stick? Will you help me up there and then I can get it out? Put that pen in there and help me. Miss M., what are you writing?"
   Subject said, "How can I get my cookie? Say, how can I get my cookie? How? How did they get theirs? How did they?"
4. *Sour Grapes or Rationalization,* (S. G. or R.)—Cases in which there was an attempt to explain away failure.

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[1] The letters in parentheses are the abbreviations by which the categories are indicated in the tables.

Examples: Subject said, "But I don't care. I can have one at home. Say, I better try some other day. I don't care if they got theirs. I don't want a cookie. Why should I have one?"

Subject said, "I have to go home now. My mother wants me."

5. *Pointing or Reaching*, (P. or R.)—Cases in which the child pointed or reached or jumped toward the basket.

Examples: Subject said, "It's too high, isn't it? It's hanging in the ceiling," and at the same time reached toward basket.

Subject jumped and reached toward basket.

6. *Manipulation*, (M.)—Some overt manipulation in the direction of the object, or trying to get a tool, but not resulting in the correct solution.

Examples: Subject took ring off hook and pulled a little bit, but put it back over hook.

Subject moved one box under the basket and climbed onto it. Subject then jumped down and took ring off hook. Then he climbed back onto box.

7. *Other Solution Suggested*, (O. S. S.)—Cases in which the child suggested other possible solution, which did not apply in the given situation because tools were not available.

Examples: Subject said, "If there was only a box, then I could get up there," meaning over the railing.

Subject said, "If there was only a block here, then I could step. Maybe I can get a chair."

8. *Other Solution Used*, (O. S. U.)—Cases in which a solution was used other than the one expected by the experimenter.

Examples: Subject climbed over railing.

Subject took ring off hook in situation where use of boxes was correct solution. Subject then bumped basket with string and knocked cookie out of basket.

9. *Knowledge Without Solution*, (K. W. S.)—Cases in which it was evident from action and conversation that the child knew the solution, but could not or would not carry it out.

Examples: Experimenter suspected that subject knew solution. After the particular situation had been brought to a close without the subject having solved the problem, the experimenter asked, "How do you suppose Bobbie got the Cookie?" Subject answered, "With the stick." Experimenter, asked, "Which one?" Subject said, "That one," pointing at the long stick beyond the railing. Experimenter asked, "How do you suppose he got that?" Subject answered "With that," pointing at the short stick. Experimenter next asked, "Then how do you suppose he got the cookie?" and subject answered, "Put it back of the box," but when the experimenter said, "You show me how he did it," the subject answered, "I can't do it."

Subject in handling long stick moved the box a little beyond his reach before he started pulling it toward him. In order to test whether the subject really knew the correct solution, the subject was allowed to try again, and the second time he put the stick carefully beyond the box and pulled it to the railing.

10. *Partial Solution,* (P. S.)—A start in the right direction, which was not followed by a solution. If there was practically continuous manipulation up to time of solution, it was not tabulated as "P. S.", even though it was something that could have been tabulated as such if the solution had not resulted. However, if there was a partial solution, then a change to some other activity, such as "Ina.", "N. R." or "R" and later the solution did occur, the first was tabulated at "P. S."

    Examples: Subject picked up short stick and reached toward box.

    Subject turned large box on end and climbed onto it and reached toward basket.

11. *Surprise at Solution,* (S. at S.)—Cases in which child did not know solution would result from his act.

    Examples: Subject took ring off hook; pulled basket to ceiling; hesitated. Subject then let go of ring. The basket fell to the floor. The subject came and stood by the experimenter and made sounds of surprise, and waited for the experimenter to tell him to get his cookie.

    Subject took ring off hook; then merely let go, and the basket fell to the floor. Subject, rather surprised, said, "Look it. Where is that little round thing? Oh! up there. How can you get it up again?"

12. *Knowledge of Solution,* (K. S.)—Cases in which manipulation was followed by solution which child expected, as indicated by his comments or the behavior as recorded.

    Examples: Subject after playing with ring and asking how to get the cookie, went back to ring, released it and held it while letting the basket lower and while getting her cookie.

    Subject said, "Get that stick," after which she proceeded to get the long stick with the short one and use the long one correctly to get the cookie.

13. *Solution Without Preceding Manipulation,* (S. W.)—Cases in which the act began at once and with no unnecessary preliminary movements.

    Examples: Subject reached right down and pulled correct string without touching others, and watched box coming.

    Subject said, "How can I get it?" paused a moment and said, "Maybe I can get it." Subject went immediately to long stick, pulled it to railing; picked it up and put it beyond cookie box and pulled it directly to railing.

14. *Solution for Sake of Solution,* (S. S.)—Cases in which the child repeated the essential activity of solution.

    Examples: After subject had removed ring and let basket lower, pulled on ring until basket was again near the ceiling and then let it lower again before taking the cookie out, although he had looked at the cookie the first time the basket was lowered.

    Subject put cookie basket as far back from the railing as possible and then repeated the act of pulling it to the railing.

15. *Miscellaneous,* (Mis.)—Special, exceptional and doubtful cases, such as those in which the subjects did not make use of the short stick in getting the long stick, but pulled the long stick to them with their feet; also cases in which the experimenter felt the subject knew the solution, but had not direct positive evidence.

TABULATION OF THE DATA

In tabulating the data, the writer went through the records for each child and noted each kind of response which a particular situation had elicited from the child. This meant that no type of response was counted more than once for the same child in a single situation. This procedure avoided the difficulty of deciding how many specific times a given reaction appeared. For example, it would have been difficult to decide *how many* times a child showed negativism during the course of a problem, or how *many times* a tabulation should be made for "Manipulation" during a given test situation, though the occurrence of negativism or manipulation to some degree were clearly apparent.

TABLE 1

Table showing all of the responses according to situations

SITUATION	AVERAGE TIME	N. R.	N.	L. S.	INC.	E.	S. O. OR R.	P. OR R.	M.	O.S.S.	O.S.U.	K.W.S.	P. S.	S. AT S.	K. S.	S.W.	S. S.	MIS.
I	5'03"	11	2	3	17	11	4	11	11	4	0	0	1	4	6	1	2	7
II	7'34"	8	2	4	16	12	4	9	19	3	2	3	8	0	6	0	1	3
III	4'20"	5	1	3	16	13	1	2	21	5	2	0	1	0	10	2	0	2
IV	4'08"	3	1	2	15	14	2	5	23	3	3	1	1	0	10	0	1	5
V	4'08"	6	1	5	10	10	3	3	19	3	3	2	5	0	7	2	1	7
Total number responses..		33	7	17	74	60	14	30	93	18	10	6	16	4	39	5	5	24
Per cent responses..		23.6	5.0	12.1	52.9	42.9	10.0	21.4	66.4	12.9	7.1	4.3	11.4	2.9	27.9	3.6	3.6	17.1

Responses in relation to the situations eliciting them

Table 1 shows the distribution of responses according to the situations which elicited them. The first fact which becomes apparent is that every situation brought out every kind of response, with the exception of those directly connected with the solution. The responses, therefore, cannot be considered functions of the particular features of any particular situation, but may be regarded as general modes of activity brought out by situations of this type. Responses connected with solutions form an exception to this general rule. Since each problem demanded a particular performance for its solution, the reaction closely associated with the solution would, of course, be determined by the special features in each case. For example:

Situation I brought out no instances of "other solution used," since no other solution than the correct one was possible in this situation.

Only Situation I brought out instances of "surprise at solution."

No cases of "knowledge without solution" appeared in Situations I or III; i.e., no child who knew the correct solution in the case of removing the ring from the hook and letting the basket lower, or in the case of pulling the cookie box to the railing by means of the string, failed to do so.

Partial solutions occurred with greatest frequency in Situations II and V, those in which the correct solution involved either the large and the small box, or the short and the long stick, thus making it possible to solve the problem part by part. It is interesting to note that this kind of activity is similar to the "partial analysis" which Ruger found to be so frequent in his adult subjects.

The largest frequency of solutions occurs in the category "knowledge of solution," i.e., solution following manipulation, in which the child knew the solution was coming. Ruger also found this sort of thing in his adult subjects.

The table also gives information concerning the *relative frequencies* of the different responses brought out by the different situations.

The largest percentage of instances out of the total number possible occurs in the category "manipulation," this kind of response having occurred in 66.4 per cent of the cases. If we combine the categories "manipulation" and "pointing or reaching" to determine how many times a response occurred of a general sort which might be called "trial and error," i.e., if we tabulate but once for each child situation in which either one or both of these kinds of responses occur, the percentage is raised to 77.1. The prominent rôle of trial and error is thus clearly indicated.

The next two largest percentages occur in the categories "feeling of incapacity" and "seeking help from experimenter." Again there is a similarity to the results of other studies. Ruger says that feelings of inability to solve puzzles were frequently mentioned by his subjects in the early stages of the experiment. The large number of cases in the second category, "seeking help from experimenter," is probably due to the fact that all the children used were very young. Heidbreder found that young children were much more likely than adults to respond to the social element of the situation, and that seeking help from the experimenter was one of the reactions in this class.

If we combine all the sub-groups under "failure to respond," i.e., if we tabulate but once for each child in each situation in which one or more of the various types of "failure to respond" occurs, we see that this response appears in 51 (36.42 per cent) of the cases.

There were 48 solutions in the experiment as a whole. This represents 34 per cent of the possible number of solutions. Out of these solutions, 39 cases came in the category "knowledge of solution," all of which followed manipulation. Solutions in the category "solution without preliminary manipulation" were rare. In the whole experiment there were only five cases of this sort. It was solutions of this kind in which Köhler was particularly interested, and it is interesting to note that this represents a very small percentage of the total number of solutions, when an attempt is made to keep a record of all the reactions made.

Responses in relation to the individuals studied

In table 2 the responses are classified according to the children from whom they were elicited. According to this table, no child showed responses of all though some children showed a greater variety of responses than others. This does not mean however, that variability of response is greater from the standpoint of situation than from the standpoint of individuals. Each child was tried out in only five situations; whereas each situation was tried out with 28 children. The wider range of response elicited by each situation may easily be due to this fact. If each child had been placed in a greater number of situations, the range of his responses would probably have been wider.

However, there are some kinds of responses common to nearly all of the

TABLE 2

Table showing all the responses made by each child in the five situations

CHILD	AVERAGE TIME	N. R.	N.	L. S.	INC.	E.	S. G. OR R.	P. OR E	M.	O. S. S.	O. S. U.	K. W. S.	P. S.	S. ATS.	K. S.	S. W.	S. S.	MIS.
1	2′	2				1			1						1	2		1
2					1				4				1		3			2
3		1			3				2		2				1			
4		3			2			3	3				1					2
5					3	3	1		5	2	2	1		1	1			
6		1			3	1			4				1	1	3	1	1	
7					4	4		3	5	2		1	1		5		1	2
8		1		1	5	1	1	1	1									
9		1				22		1	5	1	1		1	1	3			2
10			1		3	2			3			1			1			2
11					2	2	2	1	4	1					1			1
12				1	5	4	1	2	5	2	2		2		2			2
13		2	3						1									
14		2			4	3	1		3				2					2
15		1			2	3	2	3	5	2		1			2			2
16		4		2				2	2				1					
17				2	2	4	2	2	2	2	3							
18		1		4	5	1		2	4	1								
19		1		4	5	2	1	2	4	1			1					
20		4	1	2														
21		4		1	5	4	2		3	3								
22		2	2		1	4		1	3				1		2		1	1
23					2	3		1	5						5			1
24		2			3	4		3	5				2		1			
25		1			5			2	2									1
26					5	4	1	1	3	1		2			1	1		1
27					2	4			5				1	1	4			1
28					2	4			4		1		1		3	1	2	1
Total...		33	7	17	74	60	14	30	93	18	10	6	16	4	39	5	5	24
		17	4	8	23	21	10	16	27	11	6	5	13	4	17	4	4	16
		60.7	14.3	28.6	82.1	75.0	35.7	57.1	96.4	39.3	21.4	17.9	46.4	14.3	60.7	14.3	14.3	57.1

children. The relative frequency of the number of children from whom the response was elicited is as follows:

"Manipulation" was shown by all but one child, or by 96.42 per cent of the children. Some type or other of the "failure to respond" group was shown by 74 per cent of the children. "Incapacity' 'was shown by 82.14 per cent of the children. "Seeking help from the experimenter" was a response shown by 75 per cent of the children. Cases of "knowledge of solution," in which manipulation was followed by solution which the child knew was coming, appeared among 60.71 per cent of the children.

Though these numbers cannot be taken in an absolute sense, they indicate that these children had strong tendencies to reaction in some way when placed in this type of situation. There was but one child who consistently showed only one kind of response, and that was found in the "failure to respond" group of categories. This child consistently responded to something other than the problem.

Relation between age and responsiveness to problems as such

The data were also analyzed to see whether there was any relation between age and responsiveness to a problem as such. This question has been considered by Heidbreder (7, 8, 9) who noted that responsiveness to a problem as such rarely occurred below the four-year-old age level.

TABLE 3

Table showing percentage distribution of responses mentioned in relation to chronological age

C. A.	NUMBER OF CASES	N. R.	E.	INC.	MAN.	P. OR R.	O. S. S.	S. G. OR R.
2 year olds.	3	100	6.6	33	47	27	6.6	0
3 year olds.	11	40	33	60	56	20	9	12
4 year olds.	14	20	59	51	79	21	17	25
Correlations with C. A.		−.74	+.64		+.44	−.03	+.35	

In order to bring out the evidence on this point the categories of "failure to respond," "asking experimenter for help," "feelings of incapacity," "pointing or reaching," "manipulation," "rationalization or sour grapes," and "other solutions suggested," were studied. These categories include all kinds of responses noted except those having to do directly with the kinds of solution. Those having to do with solution will be taken up later in a separate discussion. These categories were studied to see whether particular responses were likely to occur at particular age levels, in order to determine the extent to which the child was responding to the problem.

The percentage of each response was computed for each age group by dividing the actual number of times the response occurred by the possible number of times it might have occurred. In getting the percentages in the case of the "sour grapes or rationalization," the procedure varied a little, as the number of times the response occurred was not divided by the number of times it might have occurred, but by the number of times in which failure occurred at each age level, in order to determine the percentage of cases in which the children rationalized their feelings. The results are presented in table 3. Correlations were also computed between these responses and C. A.

Failure to respond. All the cases under the "failure to respond" were considered together in this part of the analysis. When the percentages are computed for the different age levels, it becomes evident that there is a constant decrease in the percentage with increasing age. At age two the percentage coming under this category is 100. This does not mean that "failure to respond" represents the total activity of the child, but that for as least a part of the time, or in some of the cases the whole time, the child was not responding to the problem situation as such. At age three the percentage of cases in this category is 40; and at age four it drops to 20, showing that with age there is an increase in responsiveness to this type of situation, and it appears that the most distinct break comes between the ages two and three. However, the number of cases at age two is too small to warrant generalizing. The correlation between chronological age and "failure to respond" is $-.738 \pm .058$.

Asking experimenter for help. Another line of evidence pointing to this increase in responsiveness with age comes from a consideration of the cases tabulated under "asking experimenter for help." At age two there was but one response out of a possible 15, or $6\frac{2}{3}$ per cent listed under this category. At age three the percentage increases to 33, and at age four to 59. It is, therefore, not the youngest children who ask most often for help or information with regard to manner of solution. It appears that there must first be a certain amount of responsiveness to the problem situation as such, before the need for assistance is felt. The correlation between chronological age and "asking experimenter for help" is $+.642 \pm .075$.

Feelings of Incapacity. A third line of evidence comes from a consideration of the number of responses of a feeling of "incapacity." At age four 51 per cent of the possible responses are listed under this category. At age three the percentage is 60, and at age two the percentage is 33. A possible explanation of the fact that the percentage does not go up between ages three and four is that the four-year-olds were able to solve more of the problems, and this would eliminate the feelings of "incapacity" somewhat, although a feeling of "incapacity" was often followed later with a solution.

Pointing or reaching. When we consider the category "pointing or reaching," we find but slight age differences and those not consistent. At age two the percentage of responses appearing in this category is 27; at age three the percentage is 20; and at age four the percentage is 21. The four-year-olds are just about as apt to reach or point at the object or goal as are the two-year-olds. The correlation between chronological age and "pointing or reaching" is $-.026 \pm .127$.

Manipulation. When the category "manipulation," in which the child is overtly manipulating objects, is considered, however, we have a definite increase with age. The cases in this category at age two are but 47 per cent of the number possible. At age three it is raised to 56 per cent, and at age four to 79 per cent. The correlation between chronological age and "manipulation" is $+.435 \pm .103$. It is interesting to note that this correlation is lower than the correlation between chronological age and "asking the experimenter for help." This is due to the fact that the tendency to manipulate was fairly strong even in the lowest age group, whereas "asking the experimenter for help" was much less common at the lower age levels.

Sour grapes and rationalization. At

age two, where there were no solutions, there was no attempt at rationalization and no response of the sour grapes variety. At age three, where there were fourteen solutions and forty-one failures, there were five cases of "rationalization and sour grapes" or 12 per cent of the cases of failure. At age four, where there were thirty-four successes and thirty-six failures, there were nine cases of "rationalization and sour grapes" or 25 per cent of the cases of failure. Apparently the children become more concerned about their failures; or no doubt, there may be a constant increase in the number of recognitions of failure as such, for in the cases where there is failure to respond to the problem situation, there is also, no doubt, a corresponding failure to recognize the failure to solve the problem.

Other solutions suggested. Other solutions than the particular one which was expected for a given situation were suggested in 17 per cent of the cases at age four, in only 9 per cent of the cases at age three, and 6.6 per cent of the cases at age two, showing an increase with age in the number of solutions suggested by the situation even though the necessary tools might be lacking. The correlation between chronological age and number of "other solutions suggested" is +.345 ±.112.

On the whole, then, there is evidence of an increase with age of responsiveness to a problem as such. Reactions included in the "failure to respond" group of categories steadily decrease in relative frequency with increase in the age of the groups, while "manipulation" and "seeking help" which imply a direct reaction to the problem itself, show an increase. "Feelings of incapacity" and rationalization do *not* occur at the lowest age level, where indications of responsiveness to a problem are almost entirely lacking, but are most frequent at the ages where the subjects show signs of recognizing the problem, but are not as yet able to solve it. The correlations range from −.74 ±.07 between chronological age and "failure to respond" to +.64 ±.17 between chronological age and "asking the experimenter for help."

Relations between age and the ability to solve problems

The question of whether the ability to solve problems is related to maturity was also considered. The question was answered by noting the distributions of solutions at different age levels (both chronological age and mental age), and by noting the correlations between age and solutions. The distributions are given in table 4.

From the standpoint of C.A. the results are very clear. There is a definite increase with age in the number of solutions per child. At age two the average number per child is 0; no child under two and one-half years of age solved any problem. At age three the average number of solutions per child is 1.3, and at age four is 2.4.

From the standpoint of M.A. the results are at first less clear. When M.A. is considered, age groups are less clearly defined, for the range covered is from twenty-seven months to seventy-eight months, and when this is divided into age groups, there is but one child under two and one-half years, and he makes no solution; there are nine children between two and one-half and three and one-half with an average number of solutions per child of 1.5; ten children between three and one-half and four and one-half with an average number of solutions per child of 2.1; five children between four and one-half and five and one-half with an average number of solutions per child of 1.4; two children between five and one-half and six and one-half, (one of them being five years-seven months and the other exactly six years six months), with an average number of solutions per child of 3.5.

TABLE 4

Table showing distribution of solutions according to C. A. and M. A. by average number and percentage

C. A.				M. A.			
C. A.	Number of cases	Average number per child	Percentage	M. A.	Number of cases	Average number per child	Percentage
2 year olds	3	0	0	2 year olds	1	0	0
3 year olds	11	1.3	26	3 year olds	0	1.5	30
4 year olds	14	2.4	62	4 year olds	10	2.1	47
				5 year olds	5	1.4	45
				6 year olds	2	3.5	88

However, an inspection of the raw data suggested that the average number of solutions per child does not present a very accurate picture, for it does not take into account the cases coming under the categories "other solution used" and "knowledge without solution." Failure to consider cases in the category "other solution used" distort the results because these cases have no chance of being included in the average number of solutions, since they do not tell anything about whether or not the child is capable of solving the situation as set up by the experimenter, but on the other hand, they do lessen the possible chances that the child has of solving all five situations. These cases were taken into account by subtracting them from the number of solutions occurring as compared with the number possible. A correction was also made for "knowledge without solution." It was considered equivalent to solution, because the question in this particular connection was whether the child knew how to solve the problem and not whether he actually went through the motions. A percentage distribution of solutions according to the M.A. groups worked out on this basis follows:

MENTAL AGE	SOLUTIONS
	per cent
Under 2½ years	0
2½-3½ years	30
3½-4½ years	47
4½-5½ years	45
5½-6½ years	88

There is a very slight difference in the reverse direction between the four year group and the five year group, but the series as a whole indicates a consistent tread.

When the same changes are made in tabulation, i.e., when the categories, "other solutions used" and "knowledge without solution" are treated in the manner described, C.A. differences are also brought out more clearly. A percentage distribution of solutions according to C.A. groups worked out on this basis follows:

AGE	SOLUTIONS
	per cent
Under 2½ years	0
2½–3½ years	26
3½–4½ years	62

This shows an even greater age difference than when we considered merely the average number of actual solutions per child.

The same trend of relationship between ability to solve problems and age is shown by correlations between solutions and mental age. The correlations between solution (including cases of "knowledge without solution") and chronological age is +.464 ±.1 and between solution (including cases of "knowledge without solution") and M.A. is +.422 ±.107. In summary, then it may be said that there is a positive and significant relationship between the ability to solve problems and both M.A. and C.A.

Transfer from one situation to another

One of the criteria which Köhler uses to distinguish between intelligent and unintelligent behavior is the reaction of the subject when, at a later time, he is placed in a situation which he has solved. If he has solved the situation through "insight," he will immediately produce the correct reaction; if he has solved it by trial and error, the correct reaction will not appear immediately.

It was not possible to make exactly this test in this experiment, but an approximation was attempted. For example, Situation II was made similar to Situation I in that in Situation II, when the child reached the basket by climbing on boxes, the ring and string by which the basket could be lowered in Situation I were also present, but the string was not attached to the basket. The question was whether in solving the first problem the child had merely reacted to the ring on the hook because it was the only object in the room to which he could react with manipulation or whether he would immediately try to use the same procedure in the second situation. Had the child understood why the method he had used in Situation I had brought about the solution?

In the case of Situation I, eleven of the 28 children removed the ring from the hook, two others looked at the ring and one played with the string. Of the eleven who removed the ring in Situation I, ten removed it when placed in Situation II. The one child who did not, but who had done so in Situation I watched the basket carefully when he moved the string a trifle, and said, after talking about using the boxes, "I just did that other one to take that down, (pointing at the ring). That won't work this time." Of the ten individuals who removed the ring in both situations, eight continued to pull hard, jerked hard on the string, or else asked the experimenter why the cookie did not come down this time. One of the two who did not react in this manner put the ring back immediately, giving no reason for doing so, while the other child explained during the situation why it did not work. The latter child had shown "surprise at solution" in Situation I, but had also shown a marked interest in why the solution had been brought about. After removing the ring the second time in Situation II, and observing at the same time, "It doesn't come down. It's not fastened onto the basket there you see," and after succeding in getting the cookie by the use of the two boxes, this child said, "I climbed up and got it. Is that why you had the boxes? I know because you didn't have the string fastened."

Only two children who had not removed the ring in Situation I did so in Situation II. One of these had merely looked at the ring in Situation I, and in Situation II put it back immediately after removing it. The other child who had expressed only negativism during the first situation played with the ring and let it swing this time. One child who had looked at the ring in Situation I took hold of the ring but did not remove it in Situation II. Two children who had neither touched nor looked at the ring in Situation I touched the ring but did not remove it. The child who merely played with the string in Situation I, payed no attention to the ring or string in Situation II.

There is evidence, therefore, for three statements: (1) that ten of the 11 children who solved Situation I did so without complete understanding, since they applied the solution uncritically in a situation changed in a crucial manner and (2) that one of the solutions had been made with an understanding sufficiently clear to enable the child to offer spontaneously an explanation of the change in his procedure, and (3) that one child who had shown "surprise at the solution" in Situation I was able to explain what had been changed when placed in Situation II.

Situations III and IV were also somewhat similar. In fact Situation IV resembled Situation III in all respects except that none of the strings were attached to the box and that the sticks were present. Thirteen children solved Situation III, five of them pulling only the correct string. Of these 13 children, ten pulled or moved one or more of the strings in Situation IV; one looked at the strings only and then immediately solved the problem with the stick; another looked at the strings, said, "I am going to pull this, but I can't get it," (indicating the cookie), but did not touch any of the strings, and later said, "I pulled that string once and got it, but it won't come today," and the other one of the thirteen children did not even look at the strings. The two who merely looked at the strings in Situation IV had been ones who had pulled only the correct string in Situation III.

Of the ten children mentioned as doing something with the strings in Situation IV, one merely pushed all the strings away, but did not pull any; another said after looking closely, "How can I get the string?" but took hold of the two strings opposite the basket and pulled a trifle; another said, "Is there any string on it?" pulled two of the strings, looked a while then pulled two more and played with all of them; another pulled each string a trifle, watching the box at the same time and then said, "I guess I can't get it;" another pulled three of the strings and then said, "Oh, I can't. How can you pull it?" three of them pulled the strings but said nothing about it; while another asked where he should pull or reach his cookie and tried to get one of the strings back to the box so that he could pull the box to him, saying, "guess I'll pull it by a string. Then I can get it out;" and the other one of the ten said, "How can you? There isn't any string on it," but went ahead and pulled one string anyway, and then said, "How can we get it? The string broke."

This last child who was able to explain why the box would not come, and the child, who though he did not touch the strings in this Situation, explained, "I pulled that string once and got it, but it won't come today," are the same two respectively, who in Situation II explained that the problem could not be solved by releasing the ring although that had been the correct solution in Situation I.

Of the children who did nothing with the strings in Situation III, two of them pulled a string out in Situation IV, one of these merely playing with it and trying to poke it through the key hole; and a third touched all five strings but did not pull any of them. The rest of the children paid no attention whatsoever to the strings.

Judging from these results there was evidently more understanding in Situation III than there had been in Situation I. In general, the behavior of the children who had solved Situation III showed two features when presented with Situation IV: (1) a tendency to carry over the manipulation of the string to a new situation in which it appeared, and (2) a tendency to suspect that the old solution would not work, even when they used it.

It is especially interesting to note that these results indicate that the understanding of a situation exists in *degrees* and that the complete understanding which Köhler characterizes as insight represents one extreme of the distribution, when all cases are considered. Ruger and Miss Alpert also found that understanding or "analysis" or "insight" existed in various degrees of completeness.

DISCUSSION AND CONCLUSIONS

The experimental procedure used in this study places a number of difficulties in the way of interpretation. There are several factors which cannot be controlled. Interest, motivation, and general attitude cannot be held constant from child to child even when they are of the same age, and when comparisons are attempted between children and adults and between human beings and animals, the matter becomes even more difficult. Besides, individual differences in past experience and in inherited natures operate in cases of this sort, and cannot be equalized.

It is difficult, too, to follow and interpret correctly the problem solving activities even of adults, who in addition to their overt behavior, give verbal accounts of their activities. It is even more difficult to follow the activities of children, since cues are more limited, and interpretations must be based on their overt activity plus a few chance remarks which occur seldom and when they do give only meager explanations of their activity.

Results from studies such as these, as yet at least, cannot be measured in any definite manner or by any yardstick of values. The study is thus limited to the device of simple enumeration. Decision as to categories was based on the experimenter's judgment, subjectivity being guarded against by immediately and as fully as possible making a record of what the child did and said, by defining the categories as objectively as possible, and by using only the words of the subject or activity which seemed readily understandable to determine in which category the behavior should be listed. A possible way to determine the objectivity of tabulation is to give the data which has been collected and the list of categories with the definitions to a group of judges, and ask them to tabulate it, and then determine the degree of agreement between judges. This was not done in this experiment because it was impossible to secure enough judges to examine all the data. However, one person besides the experimenter examined the data and disagreement was found only with regard to two categories, those being "P.S." and C.S.S." The results, therefore, merely represent general tendencies.

SUMMARY

1. Every situation used in the experiment called out a wide range of responses. Every kind of response observed occurred in all the situations, with the exception of responses directly connected with solutions and these were often directly determined by the concrete features of the particular situation. The responses as a whole, however, may be considered a function of the general type of situation presented, not of the particular situation.

2. The responses which occurred most frequently were those classified as "manipulation," and "pointing and reaching." The prominence of trial and error in the problem solving of children is indicated by this fact, since the categories "manipulation" and "pointing and reaching" include the reactions usually called trial and error.

3. The responses which ranked next in frequency were those classified as "feelings of incapacity" and "asking the experimenter for help." "Feelings of incapacity" did not always indicate inability to meet the situation; they were often followed by trial and error and sometimes by solution. "Asking the experimenter for help" occurred principally in children who responded actively to the problem, not in those who made no attempt at solution.

4. Individuals varied in the range of responses elicited by the situations, but some type of problem solving behavior was elicited from every child, with one exception, by at least one of the situations. From most of the children, solving activities of some sort were elicited by all the situations. The percentage of cases, when all children and all situations are considered, in which only "failure to respond" was recorded, was but 10.7.

5. A positive relationship was found between chronological age and responsiveness to a problem as such.

This is indicated by the fact that the number of problem solving reactions increased with age and the number of failures to respond decreased with age. "Pointing or reaching" was the only type of response observed which did not show a definite increase or decrease with age. This positive relationship is also indicated by marked positive correlations between chronological age and "manipulation," "asking experimenter for help," and "other solutions suggested," and a marked negative correlation between chronological age and "failure to respond."

6. The ability to solve problems was positively correlated with both mental and chronological age. This is shown by the fact that the number of solutions increases with both chronological and mental age, and that statistically significant positive correlations are obtained between the number of solutions and both chronological and mental age.

7. Solutions were of various sorts, "solutions at which the child showed surprise," "manipulation followed by solution which the child knew was coming," and "solutions which occurred without preliminary manipulation." Solutions of this latter sort, which according to Köhler showed "insight" occurred, but were rare. The results of this study are in harmony with those of Ruger and Alpert in indicating that understanding of the solution of a problem may exist in various degrees.

REFERENCES

(1) ALPERT, A.: The solving of problem situation by pre-school children. Teachers College Contributions to Education, 1928, No. 323.

(2) DUNCKER, K.: A qualitative (experimental and theoretical) study of productive thinking (solving comprehensive problems). Ped. Sem., 1926, 33, 642–708.

(3) HAGGERTY, M. E.: Imitation in monkeys. Jour. Comp. Neur. and Psychol., 1909, 19, 337.

(4) HEIDBREDER, E. F.: An experimental study of thinking. Arch. of Psychol., 1924, No. 73.

(5) HEIDBREDER, E. F.: Problem solving in children and adults. Ped. Sem. and Jour. Gen. Psychol., 1928, 35, 522–545.

(6) HEIDBREDER, E. F.: Reasons used in solving problems. Jour. Exper. Psychol., 1927, 10, No. 5, 397–414.

(7) HELSETH, I. A.: Children's thinking. A study of the thinking done by a group of grade children when encouraged to ask questions about United States history. Bureau of Publications, Teachers College Columbia University. 1926.

(8) KOFFKA, K.: The growth of the mind. New York, 1924, Harcourt, Brace.

(9) KÖHLER, W.: The mentality of apes. New York, 1925, Harcourt, Brace.

(10) PIAGET, J.: Language and thought of the child. New York, 1926, Harcourt, Brace.

(11) RUGER, H. A.: The psychology of efficiency. An experimental study of the processes involved in the solving of mechanical puzzles and in the acquisition of skill in their manipulation. Columbia Contributions to Philosophy and Psychology, 1910, 19, No. 2.

(12) THORNDIKE, E. L.: Animal intelligence. Experimental studies. New York, 1911, Macmillan.

(13) WATSON, J. B.: Behaviorism, an introduction to comparative psychology. New York, 1914, Henry Holt.

(14) YERKES, R. M.: The mind of a gorilla. Genet. Psychol. Mono., 1926–1927, 1 and 2.

A Comparative Study of Visual Apprehension in Nursery School Children and Adults[1]

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PURPOSE OF THE PRESENT INVESTIGATION

THE number of separate items which can be apprehended and reported from briefly exposed material presented either simultaneously or serially may probably best be termed the "span of visual apprehension." A compilation of experimental results obtained with adults as subjects shows that the span of visual apprehension varies with (1) the method of scoring employed, (2) the completeness of the report demanded from the subjects, (3) the length of the series exposed, (4) the duration of the exposure, (5) the color or brightness of the stimuli, (6) the amount of practice of the subjects, and (7) the nature of the stimulus material. These results have been summarized by Tinker (7).

Interest in the effect of age upon perceptual span and in the relation between this span and reading ability has led to a considerable amount of research on school children. Two principal conclusions would seem to be substantiated by a survey of these investigations. First, the length of the span is positively correlated with chronological age and second, the length of the span is positively correlated with measures of general mental ability.

Since, however, none of these previous investigations used subjects younger than about six years (first grade pupils), questions such as the following suggested themselves. What would be the perceptual span for a group of pre-school children? How would it correlate with chronological and mental age? More fundamentally, would a test of visual apprehension yield reliable and valid scores at this early age level?

Uniform motivation is particularly difficult to obtain at the pre-school level. Apparently, the best plan is to make the task as intrinsically interesting as possible in the hope that when each is doing what he enjoys, all are about equally motivated. In accordance with these considerations, then, toys were selected as being the type of stimulus material most likely to be of interest to young children, and thus likely to yield the truest or most valid measure of their perceptual span. On the further assumption that different types of toys might possess different degrees of interest value and that these differences would be revealed in the responses, it was decided to use two main classes of stimuli, first, toy animals, and second, toys other than animals. It also seemed desirable to test a group of adults under conditions as nearly like those used with children as possible and to compare the performances of the two groups.

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[1] From the Psychological Laboratories, the University of Minnesota. The writer wishes to acknowledge her indebtedness to Dr. Miles A. Tinker under whose direction this problem was completed and to Dr. John E. Anderson and Dr. Josephine C. Foster for permission to test children enrolled in the Minnesota Nursery School.

The purpose of the present investigation, then, is fourfold: (1) To determine the span of visual apprehension for toys among pre-school children and the relation between this span and measures of maturity. (2) To determine the part contributed respectively by the apprehension of toy animals and by the apprehension of toys other than animals, to a total score in visual apprehension. (3) To compare the performance of a group of adults on this test of visual apprehension with that of young children on the same test. (4) To determine the feasibility of testing span of visual apprehension at the pre-school level.

SUBJECTS IN THE EXPERIMENT

Two groups of subjects were used in the experiment. The first consisted of 30 children attending the nursery school conducted by the Institute of Child Welfare at the University of Minnesota. Fifteen of them were boys and fifteen were girls. Information was obtained from the nursery school records on the occupation of each child's parent and the classification of that occupation according to the Barr-Taussig scale (in which Class I is described as "professional;" Class II, as "managerial;" Class III, as "clerical;" Class IV, "skilled labor;" Class V, "semi-skilled labor;" Class VI, "unskilled labor"). In comparison with the distribution of occupations in the city of Minneapolis as a whole, this small group contained a disproportionate representation from the upper two classes at the expense of the lower ones. The mean chronological age of the 15 boys at the time of taking the visual apprehension tests was 47.0 months with a range from 36 to 58 months, and the mean age of the girls was 47.3 months with a range from 34 to 58 months. The I. Q. for each child was obtained from records on file in the nursery school. For the boys, the mean I. Q. was 114.9 (range 84–131), and for the girls, 112.2 (range 92–128). Assuming constancy of the I. Q., a mental age was determined for each child by multiplying his chronological age at the time of the visual apprenehsion tests by his I. Q. The average mental age of the boys was 53.4 months (range 43.9–69.6) and of the girls was 53.0 months (range 38.1–71.5).

The second group of subjects was composed of 30 University of Minnesota students, 15 men and 15 women. About one-third of them were graduate students in psychology.

APPARATUS AND METHOD

The essential feature of the exposure apparatus built for this experiment was a vertical frame supporting an ordinary window shade with the ratchet on the spring held back so that when a retaining cord was released, the curtain would roll up revealing the stimulus material spread out on a table top.[2] A low table placed to the left of the apparatus contained all the toys used as stimuli. A vertical cardboard screen, 4½ feet high, parallel to the left side of the apparatus, concealed these toys from the subject. The examiner stood behind this screen, a position from which she could easily operate the cord controlling the curtain, transfer toys from the table at the left to the exposure table, and watch the child to see that he maintained continuous fixation on the toys for the duration of the exposure.

A preliminary survey using as subjects seven of the two-year-olds in the nursery school yielded 11 animals and 12 inanimate objects suitable for use with children. The toys were all of approximately the same size, about 5 inches long, 2½ inches wide, and 5 inches high on the average.

With children, six items (three animals and three inanimate objects) were placed on the table for each exposure, and in the total of 50 trials, each toy was used approximately the same number of times. Grouping of the toys on the exposure table varied from trial to trial. No object appearing in the first exposure was shown again before the fourth, none in the second appeared again before the fifth, etc.

For testing adults, 14 animals and 13 inanimate objects were added to those used with children. In an endeavor to have a situation which would be relatively as difficult for the older subjects as was six items per exposure for children, it was decided that for adult testing each exposure should contain ten objects (five animals and five inanimate objects).

For both groups of subjects, the duration of the exposure was three seconds. All tests were administered individually in a small, well lighted room containing nothing but the apparatus used in this experiment.

Several aspects of the testing procedure, made necessary by the extreme youth of the subjects, seem worthy of enumeration. (1) To minimize fatigue, the 50 trials given each subject were administered in short series of ten trials on each of five different days. (2) Each child was given an opportunity to name all of the toys before each day's testing. (3) Practice trials sufficient in number to teach each child his part of the "game" preceded the experimental series of exposures. (4) The child was allowed to play with a toy while the experimenter was changing the stimuli for the next trial.

Adults were tested in two sittings of 25 trials each. At the beginning of each day's testing, the subjects were asked to name over all the objects on the table. They were handed written instructions, and had one practice trial before the first group of 25 trials, but none before the second series. Each trial was preceded by the usual signals, "Ready!"—"Now!" and then, after an interval of about 1½ seconds, the exposure was given.

Both children and adults gave their responses orally and immediately at the conclusion of the exposure, naming as many of the objects as they could remember. Scoring was in terms of the number of items correctly reproduced per trial.

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[2] A complete description of the apparatus, the stimulus material, and the method used in this investigation, as well as the detailed results are given in the Master's thesis (1930) of the same title on file in the library of the University of Minnesota.

DISCUSSION OF RESULTS

Three scores were computed for each person tested, (1) the average number of items correctly named per trial, (2) the standard deviation of the 50 scores on the separate trials of the experiment, and (3) the coefficient of variation $\left(\frac{\sigma_{\text{dist}}}{\text{mean}}\right)$. These data are presented in table 1 which is to be read as follows: Column 1 gives the central tendency of the average perceptual spans for the various sub-groups; column 2 presents the standard deviation of the distribution of these averages for each group; and column 3 shows the range of spans within each group. Similar summaries are presented in columns 4, 5, and 6, for the measures of absolute variability (standard deviations) and in columns 7, 8, and 9 for the scores in relative variability (coefficients of variability).

TABLE 1

The distributions and means of three visual apprehension scores for the various groups of subjects tested

GROUP	NUMBER	AVERAGE SPANS			STANDARD DEVIATIONS			COEFFICIENTS OF VARIABILITY		
		Mean	$\sigma_{\text{dist.}}$	Range	Mean	$\sigma_{\text{dist.}}$	Range	Mean	$\sigma_{\text{dist.}}$	Range
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Boys	15	1.960	0.662	1.10–3.32	0.813	0.165	0.500–1.150	0.446	0.119	0.239–0.719
Girls	15	1.873	0.461	1.04–2.84	0.899	0.112	0.747–1.150	0.516	0.110	0.303–0.718
All children	30	1.919	0.572	1.04–3.32	0.856	0.148	0.500–1.150	0.480	0.119	0.239–0.719
Adults	30	6.17	0.686	4.82–7.26	1.210	0.152	0.87 –1.55	0.197	0.026	0.160–0.256

Inspection of table 1 reveals that for the group of 30 children, the average span of visual apprehension is slightly under two items, and data presented in column 3 of the table shows that here, as has usually been found, there are wide individual differences in perceptual span. The average span for the group of 30 adults was 6.17 items, almost exactly what Whipple (5, 6) found for three adults using very similar stimulus material and a six second exposure. The average span for his group was 6.07 items.

The amount and the statistical significance of the differences between the averages found for children and those found for adults in the three visual apprehension scores are presented below:

$$\text{Mean}\ldots\ldots\ldots D = +4.25 \qquad \frac{D}{\sigma_D} = 27.21$$

$$\text{S. D.}\ldots\ldots\ldots D = +0.372 \qquad \frac{D}{\sigma_D} = 8.77$$

$$V\left(\frac{\text{S.D.}}{\text{Mean}}\right)\ldots D = -0.272 \qquad \frac{D}{\sigma_D} = 13.20$$

In length of span and in amount of absolute variability averages for adults (as is indicated by the plus sign preceding the difference) are significantly larger than those for children. In relative variability, however, children exceed adults. The significantly larger perceptual span for the adult group falls in line with previous work which has shown that the greater the difference in age between two groups, the greater will be the difference in span of visual apprehension favoring the older group. That the children are relatively more variable than the adults probably means that factors influencing the perceptual span on a test of this sort, such as interest, motivation, attention, and understanding of directions remain more constant from trial to trial in an adult than they do in a young child.

A matter of paramount interest in the present investigation was the reliability with which the technique used was measuring the span of visual apprehension. Two split-scale reliability coefficients were computed for each group of subjects. Individual scores for the odd-even reliability coefficients were determined by totaling separately the number of objects correctly reproduced on the 25 odd-numbered trials and the number correct on the 25 even-numbered trials. The second reliability coefficient was a correlation between total scores on the first 25 trials and total scores on the second 25 trials. Both coefficients were raised by the Brown Spearman formula to show the probable reliability of the test as a whole. These reliability coefficients are presented below:

Children (Odd-Even). $r = .91$, $r_x = .96$
Adults (Odd-Even) .. $r = .85$, $r_x = .92$
Children (1st vs. 2nd half) .... $r = .84$, $r_x = .91$
Adults (1st vs. 2nd half) .... $r = .70$, $r_x = .82$

All of the coefficients are high enough to justify group comparisons. Reliability coefficients are higher for children than for adults, a function, very likely, of the relatively greater range of individual differences among the younger subjects. Because these individual differences were found to be highly correlated with chronological age, it seemed desirable to attempt to determine what the odd-even reliability would have been had the group been more homogeneous with respect to age. To this end, the children were divided into two smaller groups, the first a group of 16 four-year-olds whose actual ages ranged from 48 to 59 months, and the second, a group of 14 entitled "three-year-olds" whose actual age range was from 34 to 47 months. The odd-even reliability coefficients for these smaller groups appear below:

Age 4....... N = 16, $r = .71$, $r_x = .83$
Age 3....... N = 14, $r = .89$, $r_x = .94$

These coefficients are of respectable magnitude, particularly in the younger group. The method is open to the criticism that we have not really achieved homogeneous age groups since one year at this level represents a relatively wide range of ages. The small number of cases, however, prohibited any further sub-division. Furthermore, selecting two groups which are at least less heterogeneous in age than the total group, gives us reliability coefficients which are somewhat lower than the original one. We may, therefore, assume that our first reliabilities are higher than we could expect to obtain from testing individuals all of the same age.

To measure practice effect on this test, the *total scores* computed for the first 25 trials and second 25 trials separately were averaged for the whole group. Results from this treatment of the data appear in table 2. The group of adults showed an improvement which amounts to a little less than one item in terms of average span. This is slightly greater than the amount of gain found by Whipple (5, 6), during a practice period of 27 exposures for each kind of material. Volunteered introspections from many of the subjects would seem to substantiate the same reasons for the improvement as those arrived at by Whipple, i.e., habituation to the experiment, familiarity with the material, and development of tricks of grouping.

TABLE 2

Reliability of the differences between scores on the first and second halves of the visual apprehension test

	1ST 25 TRIALS	2ND 25 TRIALS	DIFFERENCE	$\frac{D}{\sigma D}$
Adults.	146.70	161.80	+15.10	6.29
Children.	49.40	45.23	−4.17	2.71

The children, however, not only failed to gain but actually showed a lower average total score for the second 25 trials than for the first 25. There are 99.7 chances in 100 that a repetition of the experiment on a similarly selected group would result in a difference in the same direction. Apparently, boredom and fatigue are likely with young children to counterbalance any possible effect of practice on the later trials of a long continued experiment. This conclusion receives some substantiation from remarks frequently made by the children on the last days of testing.

In view of the high odd-even reliability obtained for this group of children, an interesting possibility suggested itself. If we had given just 30 trials instead of 50, would we still have measured each child's performance reliably? The odd-even reliability coefficient based on the first 30 trials alone was .86 ± .03 and raised by the Brown-Spearman formula became .92 ± .02. The corresponding coefficients based on 50 trials were .91 and .96. If, then, we are interested only in group comparisons, 30 trials per child gives us a reliability high enough to make predictions safe. If, however, we are interested in individual prediction, we had better use 50 trials. But are we increasing reliability at the expense of validity in this longer experiment? Presumably the best possible performance of an individual who is maximally motivated is the performance with which we are concerned. If interest, and with it motivation drops off markedly in the later trials of an experiment, then possibly an average based on fewer trials would be the higher, and thus the truer, measure of an individual's ability. To throw some light on this point, an average span for each child based on the first 30 trials alone was computed. These measures were averaged for the group as before. The mean of the new average spans was 1.96 items as compared with the original mean of 1.92 items. The difference between these two averages is small and not statistically significant when considered in relation to its standard error $\left(\frac{D}{\sigma_D} = 1.62\right)$. A correlation of +.97 between average spans based on 30 trials and those based on 50 trials indicates that for locating a given child's position within the group, either average is equally good.

The effect of age on span of visual apprehension is shown by a comparison of the average perceptual span for the 16 four-year-olds, 2.26 objects, with the average for 14 three-year-olds, 1.54 objects. The difference here indicated is 4.41 times its standard error and is in line with results found by other investigators. The best picture of the relation between maturity and span of visual apprehension is given by the correlations between these two variables, which appear below:

Apprehension score vs. C.A. = + .84 ± .04
Apprehension score vs. M.A. = + .72 ± .06
Relative variability vs. C.A. = − .69 ± .06
Relative variability vs. M.A. = − .72 ± .06

The correlation between total score in visual apprehension and C.A. is very much higher than any reported previously, even though the other investigators reporting correlations (Payne and Dallenbach) had a range in chronological age exceeding the range in this study. Dallenbach's (1) correlation between visual apprehension and C.A. was +.19, and Payne's (4) was about +.15. The correlation of +.72 with mental age (see above) is of about the same magnitude as similar correlations, discovered by Dallenbach (2) for his group of feebleminded subjects, and by Hoffman (3) for grade school children when familiar words formed the stimulus material in the visual apprehension experiments. Much lower correlations are reported by Hoffman when the stimulus material was unrelated consonants, and by Payne (4) for both digits and words.

The last two correlations, between measures of maturity and relative variability, indicate that the older the child, or the higher his mental level, the more closely his scores on individual trials tend to cluster about his mean score.

Table 3 shows that the group of adults correctly reproduced more of the objects which were not animals than they did of the animals. The difference between the averages is 6.04 times its sigma and is thus reliably established. The explanation of this difference would seem to lie in the fact that the inanimate objects selected as stimuli were all common and familiar objects. The toy animals, on the other hand were difficult to procure, and in order to obtain a list of 25 all of the correct size, many of the less familiar ones (giraffe, camel, etc.) had to be included. This resulted in a real difference in the speed

TABLE 3

The reliability of the differences between the number of animals and the number of inanimate objects correctly reproduced by children and adults

	INANIMATE OBJECT SCORE	TOY ANIMALS SCORE	DIFFERENCE	$\frac{D}{\sigma D}$
Adults..........	164.50	144.1	20.4	6.04
Children.......	39.03	56.03	17.9	6.07

with which they could be apprehended and named and the corresponding ease with which they could be remembered. Very few of the adults tested failed to volunteer observations substantiating this conclusion. The children, however, show a difference equally significant in the opposite direction. Clearly the same explanation cannot obtain here. As a matter of fact, the preliminary drill in maming the toys which preceded each day's testing revealed that for children, as for adults, the inanimate objects, as a group, were more familiar than the animals. It seems to the author that the factor operative at the pre-school level was a real difference in the interest and attention value of the two classes of stimuli with the animals holding the advantage.

SUMMARY AND CONCLUSIONS

1. The primary aims of the present investigation were to determine the span of visual apprehension among pre-school children and the feasibility of testing this function at this early age, to discover the relationship between this span and measures of maturity, to compare the performance of pre-school children with that of adults on the same test of visual apprehension, and to determine the relative parts contributed to a total score in visual apprehension by the reproductions of two types of stimuli.

2. Subjects used in the experiment were 30 children from the nursery school conducted by the Institute of Child Welfare at the University of Minnesota, and 30 students in the University of Minnesota.

3. The technique of the investigation was, briefly, to expose a number of toys for three seconds in an especially constructed exposure apparatus and then to ask the subjects to name all they could remember of what they had seen.

4. Split-scale reliability coefficients were all high enough to justify group comparisons.

5. Although performance on this test shows a significantly high correlation with age, reducing the age range to approximately one year by dividing the children into an older and a younger group, does not materially lower the odd-even reliability of the test.

6. The average span of visual apprehension obtained for the pre-school children acting as subjects in this experiment was 1.919 items. The average span for the adults tested was 6.17 items.

7. As a group, the adults show significantly greater absolute variability about their respective averages than do the children, but relatively, the children are much more variable.

8. Comparing total score on the first 25 trials with total score on the last 25 trials shows a slight practice effect for adults and a slight loss for children, the latter being due presumably to a decrease of interest in the "game" as the experiment continued.

9. Correct reproduction of the inanimate objects exposed contributes a significantly larger amount to the total scores made by adults than does the naming of animals. The difference appears to be due to the greater familiarity of the inanimate objects. For the pre-school children tested, the difference is equally significant

but in the opposite direction, and is attributed to the greater intrinsic interest or attention value of the animals as stimuli.

10. For children, the total score on this test of visual apprehension correlates ±.838 ±.04 with chronological age and −.724 ±.06 with mental age, thus demonstrating the predominant importance of maturity factors in determining the span of visual apprehension. Relative variability on the test correlates −.690 ±.06 with C.A. and −.725 ±.06 with M.A.

REFERENCES

(1) DALLENBACH, K. M.: The effect of practice upon visual apprehension in school children. J. Educ. Psychol., 1914, 5, 321–324; 387–404.

(2) DALLENBACH, K. M.: The effect of practice upon visual apprehension in the feebleminded. J. Educ. Psychol., 1919, 10, 61–82.

(3) HOFFMAN, J.: Experimentelle psychologische Untersuchungen ueber Leseleistungen von Schulkindern. Arch. f. d. ges. Psychol., 1927, 58, 325–388.

(4) PAYNE, C. S.: The derivation of tentative norms for short exposures in reading. Harvard Univ. Press, 1920.

(5) WHIPPLE, G. M.: The effect of practice upon the range of visual attention and of visual apprehension. J. Educ. Psychol., 1910, 1, 249–262.

(6) WHIPPLE, G. M.: Manual of mental and physical tests. Part I: Simpler processes. Baltimore, 1914, 262–296.

(7) TINKER, M. A.: Visual apprehension and perception in reading. Psychol. Bull., 1929, 26, 223–240.

The Influence of Training on the Vocal Ability of Three-Year-Old Children

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THE present investigation was designed to measure the singing ability of three year old children and to study the effects of training on the child's vocal performance.*

Initial measurements were made of the child's ability to reproduce pitch, by the singing of separate tones, and his ability to reproduce intervals, by singing of two successive tones of different pitch. Training in singing was given to a group of children during a period of several months, while an equivalent control group was tested at the beginning and at the end of the investigation. A study was also made of the children's spontaneous vocalizations.

The study offers findings with regard to such factors as the notes and intervals which can most readily be sung by three year old children, individual differences in performance, and the influence of training on vocal performance. The data furthermore provide findings with regard to the relationship between children's vocal abilities and such factors as ability to learn the melodies and words of songs, general intelligence, parents' vocal range, and the range and content of spontaneous singing.

Forty-eight children, ranging in age from 31 months to 48 months, were used in the study. Eighteen of these were given training twice weekly during a period of six months. The 18 children completed a total of 40 practice periods required for each child.

The children who were not included in the training series were tested early in the study, and as many as could be found were retested at the end of the experiment. From their number 18 were selected to serve as a control group. Each child in this group was paired, as closely as possible, with respect to age and score on the initial tests, with a child in the group that completed the training series. The control group was used to find the degree to which the improvement exhibited by the trained group could be attributed to such factors as growth, increased familiarity with the procedure, more favorable rapport with the experimenter, and other incidental conditions rather than to actual increase in vocal ability through training.

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References to published and unpublished experimental work in music can be found in the Twenty-eighth Year Book of the National Society for the Study of Education (6). References to the valuable studies conducted at the University of Iowa prior to and including the year 1928 are given by Seashore (4). The authors are not aware of published experimental results dealing with the main problems of the present study.

PROCEDURE

Tests of pitch and interval

The first step in the study was to find the number of notes and intervals which each child could sing. Two tests, which will hereafter be designated *pitch* and *interval*, were designed for this purpose.

The initial pitch test included the following 11 notes, beginning with Middle C:

C D E F G A B C D E F

The initial interval test included the following 12 intervals: Ascending and descending major and minor seconds and thirds, perfect fourths and perfect fifths.

When the pitch and interval tests were given, the children were taken in groups of two or three to a separate room and were seated at a table, facing the experimenter. They were encouraged to play on a small xylophone and permitted to inspect a picture book. The experimenter then proceeded with the test. A given note was sung by the experimenter and sounded on the xylophone or on a pitch-pipe. Two chromatic pitch-pipes, one in the key of F, the other in the key of C, were used. The children were asked to listen and to sing the same tone. Various means of encouragement, including the use of the xylophone and the picture book, were employed. The children soon learned what was expected of them, and as time went on less and less extraneous motivation was needed.

Each item of the test was presented separately, and the responses of each child to each item were separately recorded. After a given tone had been presented, the experimenter kept sounding and singing the tone to prompt the child's efforts. If the child succeeded in reproducing the tone no further response was required until the next item was presented. If he tried to sing the tone and failed to reproduce it correctly or if he remained silent the experimenter continued to sing and sound the tone a maximum of eight times. Fewer than eight presentations were made if the child's attention could not be held. If the child reproduced the presented item he was credited with a 'hit;' if he tried but failed he was credited with an 'attempt;' if he continued to remain silent, his record on the particular item was entered as 'no attempt.' A record of the number of trials preceding success was also made. Each of the 11 notes of the pitch test was dealt with in this manner.

The pitch test was administered three times, on three different occasions, during the initial test series. When the record was scored, one credit was given to each note correctly reproduced. If the child sang a given note on only one test or on all three occasions when the test was administered he received one credit. The maximum score on the pitch test was, accordingly, 11.

The interval test was administered at two separate times after the completion of the pitch tests. The general procedure was the same as that described above, save that two notes constituting an interval were presented instead of separate notes as in the pitch tests. Each interval correctly reproduced during one or both administrations of the test was given one credit in the final score. The maximum score according to this procedure was 12.

Method of evaluating the child's responses

Of first importance in a study of this kind is the need for a valid means of evaluating and scoring the responses made during the tests. Much time was spent in preliminary experimentation to find a procedure which could be used expeditiously in work with children at this early age and still yield reliable quantitative results. The use of a mechanical device, such as a tonoscope, for recording the children's responses was considered, but after preliminary work it was felt that the purpose of the study could be served without a device of this kind. The procedure of requiring the experimenter to judge the correctness of the child's response was tried and appeared to give satisfactory results. Accordingly, during the course of the tests, the experimenter not only produced the notes or intervals which the child was required to sing, but also judged whether the child's responses correctly reproduced the tones which were being presented. In forming a judgment the experimenter made use of the musical instruments as a basis of comparison between the child's responses and the tone that was required. No response was recorded as correct unless in the opinion of the experimenter it was definitely in accord with the tone which was being sounded on the musical instrument. A description of methods designed to ascertain the validity of the experimenter's judgments follows.

Reliability of the judgments of the child's responses

Various means were used in checking upon the reliability of the experimenter. First of all the experimenter was tested by another musician. The tester sang at random all the notes used on the initial tests given to the children, taking her note from a piano which was not within the hearing of the experimenter. She recorded each note thus sung. The experimenter in the meantime was required to identify (by aid of a pitch-pipe) and to record each note that was sung. After the test had been completed the tester's and the experimenter's records were compared, item by item. The experimenter made a perfect score on each of three repetitions of the test.

A more significant check on the reliability of the experimenter was obtained by introducing other musically trained examiners while tests were being given the children during the course of the study. The persons thus brought in took independent records of the children's performances while they were being tested by the experimenter.

On one occasion, 20 children were tested in this way, both for pitch and interval, by the experimenter and a second examiner. After the completion of the tests, the separate records were compared.

The pitch test on which simultaneous and independent records were made by the two examiners included the 11 notes of the initial pitch test. The total possible score for the 20 children was, accordingly, 220. An item by item comparison of the two independent records showed an agreement of over 96 per cent. (The judgments were in disagreement on only 7 notes in the total of 220.) The experimenter credited the children with 125 correct hits, one of which had been judged incorrect by the second examiner, while the second examiner credited them with 130 correct hits, six of which had been judged incorrect by the experimenter.

On the interval test, each child was tested by both examiners on the 12 intervals of the initial tests. The total possible score for the 20 children was 240. An item by item comparison of the records showed an agreement of 95 per cent. The two examiners agreed in judging 152 items as correctly reproduced and 75 items as incorrectly reproduced. The experimenter judged one response as correct which was judged incorrect by the second examiner, while the second examiner gave credit to twelve responses which were judged incorrect by the experimenter.

It can be observed that there was not only a high percentage of agreement between the two examiners, but also that the experimenter was more rigid in giving credit than was the second examiner.

The same method of checking upon the reliability of the records was used at a later stage of the experiment when still another musician was introduced to take simultaneous and independent records during the pitch tests. This musician, like the person previously introduced, possessed what is known as "absolute pitch." On this occasion, 10 children were tested on 11 notes, making a possible total score of 110. Once more an item by item comparison of the records was made at the end of the tests. The agreement in this instance was 96 per cent. Two items which had been credited as correct by the experimenter were recorded as failures by the second examiner, while on the other hand, this second examiner had given credit for 2 items which the experimenter had recorded as incorrect.

The above results indicate that the method of testing used in this study showed a high degree of reliability within the limits of the procedure employed.

The reliability of the tests, as

measured by correlating the scores obtained by the experimenter on successive repetitions ranged from +.54 ±.11 to .95 ±.02, with a median of .80 ±.06.

It can be seen that the testing procedure corresponded quite closely to the type of test situation which an individual must face under practical circumstances, in school or even in performance of a professional character. The method, while showing high reliability when employed by different examiners did not, to be sure, give a measure of the exact vibration frequency of the tone produced by the child. The measurements were, however, sufficiently precise to measure not only individual differences in general range of musical performance, but also to test a given child's ability to reproduce the various steps of the musical scale.

Extension of the tests

As the study progressed, it appeared that the children were improving to such a degree that it was necessary to extend the range of notes and intervals used in the training series and in periodic retests. The tests were therefore augmented to include the original 11 notes used in the pitch test, plus the following notes: G, A, B, below Middle C, and G, A, B, and C, two octaves above Middle C, making a total of 18 notes. The interval test was augmented by the following intervals: ascending and descending major and minor sixths and sevenths, and octaves, making a total of 22 intervals.

In order to provide an instrument to cover these additions, a psaltery was added to the pitch-pipes and xylophone which had been employed from the beginning of the study. The psaltery was tuned daily.

Methods of training

Following the initial tests the experimental children were given further training in singing. Songs taken from music books for young children were used for this purpose. The children were brought to the music room, which adjoined the playground, two at a time. The experimenter would sing the songs and ask the children to join in the singing. As the study progressed special attention was given to difficult parts of the song.

The practice period was designed to last 10 minutes. Early in the study it was not found possible to maintain the interest of some of the children during the entire 10 minutes. Later in the study, when all the children were quite eager to partake in the music training, the period was sometimes extended to 15 minutes to compensate the earlier loss of training time.

At the beginning of the training series the children were permitted to play on the musical instruments, to improvise songs of their own or to try to sing the presented song more or less as they pleased. The experimenter again used various means to stimulate the child's interest in singing the songs that were used for training purposes; for example, when one of the songs, a lullaby, was presented, the child was encouraged to accompany the experimenter in going through the motions of putting a doll to sleep, while singing; another song, which ended with the words 'peek-a-boo,' likewise could readily be acted out to the accompaniment of singing. As time went on the children responded more readily without such incidental promptings.

Eight songs were used for training purposes. Three of these were used at the beginning of the training while the others were introduced one at a time as the study progressed. During training the policy was used to group a child who showed relatively much ability with one who was less competent. Furthermore, the childen were rotated in such a way that each child would sing with a different child on different days. Each child received an average of two training periods a week. When tests were given the test took the place of the training period. If a child missed training periods by reason of absence from school, extra periods were alloted to him on his return. In addition to the initial and final tests, given in the months of December and May, respectively, the pitch and interval tests were introduced in January, February, and March. Since these tests are in themselves a form of training, the periods devoted to them are counted as a part of the child's training series. Each child received forty training periods, including the periods devoted to the tests preceding the final test in May.

Spontaneous vocalizations

A study of the children's spontaneous vocalizations constituted a separate project within the investigation.

The children were observed during the course of their free play at the nursery school during the morning hours. Each child was observed for a total period of 100 minutes, divided into at least ten intervals occurring at different times over a period of three to five months.

The investigator followed the child as closely and unobtrusively as possible. Whenever the child sang, hummed, chanted, or made outcries which could be heard clearly and which could be located on the musical scale a record of his response was made. Pitch-pipes were used to identify each response that was recorded. So far as possible, the verbal content of the child's responses, the activities accompanying his response, and the rhythmic pattern of his vocalization, if any could be observed, were also recorded.

This procedure was calculated to provide a general indication of the character of children's spontaneous singing, and of individual differences in the content of children's musical expressions during the course of their undirected activities. The results cannot be regarded as final measures of the absolute frequency of the children's singing, since notes sung in an undertone, or notes which could not be identified by reason of lack of clearness or distraction or other factors, were not entered upon the records.

RESULTS

In the presentation of the results, the topics covered in the study will be treated in the following order: findings on the initial pitch and interval tests; the influence of practice on the child's performance; the extent and content of children's spontaneous vocalizations; correlation between various measurements.

The initial pitch tests were given to 48 children, and the initial interval tests to 47, including the 18 children subsequently used for training. The age range was 31 to 48 months, average 39 months. The average number of notes sung by 48 children on the three trials of the pitch test, containing the 11 notes from Middle C to F above C an octave higher was 4.20 ±2.44. The average number of intervals sung by 47 children on the two trials of the interval test containing the 12 intervals (ascending and descending major and minor seconds and thirds, perfect fourths and fifths) was 4.32 ±2.90. The scores for the experimental and control children used in the training study are given in a later table.

TABLE 1

Number of children correctly reproducing the various notes and intervals on the initial tests, based on 3 repetitions of the pitch test, and 2 repetitions of the interval test, with allowance of only one credit for each note or interval sung during the test series

Pitch (48 cases)

MIDDLE C	D	E	F	G	A	B	C	D	E	F
10	28	30	27	29	22	13	12	11	6	5

Interval (47 cases)

ASCENDING						DESCENDING					
Major second	Minor second	Major third	Minor third	Perfect fourth	Perfect fifth	Major second	Minor second	Major third	Minor third	Perfect fourth	Perfect fifth
24	18	17	13	12	13	26	11	22	23	16	8

The results of the initial tests were examined to study the range of the children's voices, and to find where their voices were placed. Table 1 shows the number of children who were able to sing each of the notes and intervals covered in the tests.

It appears in table 1 that the notes from D to A inclusive were reproduced most readily by the children used in this study. It further appears that the closer intervals, such as the seconds and thirds, were reproduced more readily than the wider intervals. The descending intervals have a slight but not significant advantage over the corresponding ascending intervals.

The findings with regard to pitch differ somewhat from usual statements with regard to the voices of young children. The claim is usually made that songs for young children should fall within the compass extending from E first line to E fourth space. (See references 2, 3, 5.) The authors have been unable to find published experimental data to support this claim. Even less definite are many writings on methods of teaching singing to young children which state that songs should be within the compass of the child's voice, without giving definite indications of what this compass is.

The findings in the present study indicate that the voices of young children are placed lower than is commonly supposed. It appears that when actual tests were given the notes Middle C, and D above Middle C, (both of which are below the first line E), were sung considerably more readily than C and D an octave higher, and that very few children sang the E and F (an octave above Middle C) which have been regarded as well within the range of the child's voice.

It is true that the statements with regard to the range of children's voices usually pertain to children somewhat older than those used in this study. It is possible that the voices of children at the age of six favor a higher range than the voices of three year old children. But it may be said at this point, in anticipation of findings which will be presented later in greater detail, that it was found that following intensive training the children of this study scored higher on the notes below first line E than on the higher notes immediately beyond the fifth line F which has been regarded as well within the range of the voices of young children. On the final pitch tests given to the 18 children who received training the number of children who sang each of the 18 notes of the extended test was as follows:

(Middle 1st line)

G	A	B	C	D	E	F	G	A
5	15	17	18	18	18	18	18	18

5th line

B	C	D	E	F	G	A	B	C
18	17	18	17	15	15	14	13	9

In later tests of songs used for training purposes, the low notes (Middle C, D, Eb) again scored substantially higher than the high notes (D, E, F beyond C an octave above Middle C). It thus appears from the initial pitch tests, from final pitch tests given after training, and from the tests employing actual songs used in training, that three year old children, as represented in this investigation, can sing notes below the commonly accepted range quite as readily as some of the higher notes which have been regarded as well within the child's capacity.

This finding that children's voices are placed lower than is commonly supposed was unanticipated in the present study. At the beginning of the investigation, the experimenters planned their approach in accordance with the supposition that children's voices favored the higher notes. Early in the training period, however, it became evident that this procedure had to be revised. It was often found that by transposing the songs used for instruction a more ready response could be obtained. Children who had previously remained silent made efforts to sing after the songs had been transposed to a lower key. Only in the case of the spontaneous vocalizations, as will be indicated at a later point, did the children tend to favor a higher range of notes.

The results from the initial interval tests indicated that the closer intervals (i.e., the seconds and thirds) were reproduced more readily than the wider intervals (fourths and fifths). In the literature opinion is divided as to the relative ease with which children can sing narrow and wide intervals. The opinion is sometimes set forth, however, that the half-step or chromatic interval (minor second) should not be stressed in songs for the young child. Thorn (5) warns against the use of difficult half-steps; the New York Board of Education Music Syllabus (3) and Damrosch, Gartlan, and Gehrkens (1) do not formally introduce instruction in the use of chromatics in songs until the fifth year of school.

In table 1 it appears that the minor second was sung less frequently than the major second and the minor and major thirds, and slightly more frequently than the perfect fourths and fifths. The score for the minor second interval is relatively quite high, and does not tend to support the view that the chromatic interval should not be used in songs for young children. As will be shown in a later table dealing with the children's spontaneous vocalizations, the chromatic interval occurred more frequently than any other interval with the exception of the major second. On the final tests the minor second was sung by all of the 18 children who had received training.

The influence of training

Table 2 shows a comparison between the experimental and the control groups of children used in the study of the effects of training. The ages for all children are calculated to January 1, 1931. The initial tests of the experimental children were completed in December 1930, while the controls were not completed until early in 1931. This discrepancy constitutes a defect in the experimental procedure which could not be overcome entirely. To compensate, in part, for this early discrepancy, the final tests of the controls were administered after final tests had been given to the experimental children. It can be seen further that there is a difference of over a month in the average ages of the two groups. Many of the children who had been given the initial tests and paired with children in the experimental groups were not obtainable for the final tests, due to contagious diseases. The use of other children who had been given the first tests and who were still available for the final tests increased the average age of the controls as indicated on the table. In the case of the interval tests, only sixteen controls were available for comparative purposes at the end of the study.

In spite of these shortcomings, a comparison of the two groups of children before and after training offers instructive findings.

The table gives results not only on the initial pitch and interval tests (Designated Test A, containing 11 and 12 notes and intervals respectively) but also on the extended tests introduced later in the study. The control group was measured on the extended scale only on the final tests. The initial pitch test was repeated three times, the initial interval test twice; the final pitch and interval tests were given three times to the controls, and twice to the experimental children.

In scoring the tests, only one credit was given for each item; if the child sang a given note correctly only once during the series or sang it on each repetition of the test, he received one credit for his performance in either case. Accordingly, the maximum score which a child could receive on the initial and the final pitch test series was 11, and on the interval test series, 12. In the case of the extended tests, the maximum scores obtainable were 18 (pitch) and 22 (interval).

It appears in table 2 that the children who had received training scored considerably higher on the final tests than those who were tested only at the beginning and end of practice. The difference between the averages of the two groups on the final tests are reliable in all cases ($\frac{\text{Difference}}{\text{S. D. difference}}$ ranges from 3.59 to 6.84).

Tables 3 and 4 show the improvement in the average scores in pitch and interval during the course of training. Separate figures are given for the scores on the extended tests that were introduced two and a half months after the beginning of the study, when it became evident that most of the children were approaching a maximum score on the tests used at the beginning of the study.

The range of the scores on the initial pitch test represented in table 3 was 0 to 11 (maximum score, 11) on first presentation, and 8 to 11 on final presentation at the end of training. The range of the extended pitch test on first presentation was 2 to 16 (maximum 18), and on final presentation, 11 to 18. The scores on the interval test showed an initial range of 0 to 10 (maximum, 12), and on final presentation of the same test the range was 9 to 12. The extended interval test showed a range of 6 to 21, and 9 to 22 respectively on first and final presentations.

Influence of training on variability. The results in tables 3 and 4 show a tendency toward a decline in relative variability as the training proceeds. Even in the case of the extended tests introduced late in the training period the relative variability is a good deal lower than on the initial more limited tests.

TABLE 2

Comparison between average scores of experimental and control children on pitch and interval tests given at beginning and end of study of effects of training

	EXPERIMENTAL	CONTROL
Pitch (18 pairs)		
Average age in months	38.18 ± 3.69	40.11 ± 3.93
Average number notes correctly sung on first test (Test A, 11 notes)	4.22 ± 2.44	4.22 ± 2.71
Average number notes correctly sung on repetition of (Test A) at end of training	10.72 ± .11	6.44 ± 2.89
Average notes correctly sung on extended test (Test B, 18 notes) at end of training	15.60 ± 1.78	8.00 ± 3.22
Interval (16 pairs)		
Average age in months	38.75 ± 2.94	40.56 ± 3.69
Average number of intervals correctly sung on initial test (Test A, 12 intervals)	4.25 ± 3.03	4.31 ± 2.89
Average number of intervals correctly sung on repetition of Test A at end of training period	11.60 ± .67	8.00 ± 2.60
Average number of intervals correctly sung on extended test (Test B, 22 intervals) at end of training	17.0 ± 4.25	10.18 ± 4.26

The fact that there was a maximum limit to the score which a child could obtain on the tests, and the further fact that the same amount and character of training was given to all the children no doubt contributed largely to the apparent decline in variability as shown in tables 3 and 4. If the tests and the training had been graded according to individual differences exhibited early in the study it is possible that the improvement shown in the final results would be even higher than the gains set forth in tables 3 and 4, and that individual differences would have remained more constant throughout the study. It is the marked improvement shown by the group as a whole in response to a training and test procedure constant for all children, rather than the findings with regard to changes in variability, that are of major interest in the results set forth in tables 3 and 4. (When the complete voice range of 14 fathers and 15 mothers of the children who were given training were tested, the fathers sang an average of 20 notes, the mothers an average of 19. The children's average score of 15.5 notes on the final test, as indicated in table 3, does not differ widely from the average scores of the parents.)

TABLE 3

Average scores on pitch test when repeated at various stages of training given to 18 8-year old children. Separate averages given for test as extended late in training period (Test B)

TEST A 11 ASCENDING NOTES FROM MIDDLE C TO F		TEST B 18 NOTES FROM G (BELOW MIDDLE C) TO G (2 OCTAVES ABOVE MIDDLE C)	
Repetitions of test	Average number of notes correctly sung	Repetitions of test	Average number of notes correctly sung
December	4.22 ± 2.44		
January	4.56 ± 2.90		
February	6.50 ± 3.33		
March	8.78 ± 2.00	March	10.67 ± 2.78
May	10.72 ± .11	May	15.50 ± 1.78

TABLE 4

Average scores on interval test repeated at various stages of training given to 18 8-year old children. Separate averages given for test as extended late in training period (Test B)

TEST A ASCENDING AND DESCENDING MAJOR AND MINOR SECONDS, MAJOR AND MINOR THIRDS, PERFECT FOURTHS AND FIFTHS (TOTAL: 12 INTERVALS)		TEST B ASCENDING AND DESCENDING MAJOR AND MINOR SIXTHS, MAJOR AND MINOR SEVENTHS, AND OCTAVE, PLUS INTERVALS OF TEST A (TOTAL: 22)	
Repetitions of test	Average number of intervals correctly sung	Repetitions of test	Average number of intervals correctly sung
December	3.94 ± 3.05		
January	4.33 ± 2.89		
February	8.05 ± 2.61		
March	9.33 ± 2.33	March	11.11 ± 3.44
May	11.56 ± 1.00	May	17.44 ± 4.00

Children's attitude toward prolonged training. A further word should be said with regard to the response of young children to training in singing over a long period of time. The quantitative findings above have already indicated that the children reacted favorably to the procedure. During the course of the study evidences of the children's continued interest and willingness to coöperate appeared in many forms. At nearly all times the children willingly left their play to go to the room where the music was given. The children were never coerced. On rare occasions a child would temporize or refuse because of the attraction of the play in which he was engaged, but the following day he would often ask to be allowed to come to the music room. All of the children on many occasions asked for permission to come next, while many of them made daily requests for a turn at music. Sometimes a child would object to leaving the playground at the usual time prior to luncheon if he had not spent a period at music. On the whole, after the study was in progress, more persuasion was used in getting the child to leave the music room than in requesting him to come. The children tested for control purposes, although seen less frequently, showed an eager interest after brief acquaintanceship with the procedure.

Before the study was begun, the question as to whether the interest and coöperation of children could be maintained seemed almost as significant as the question regarding the possibility of improving children's performance in singing. The responsiveness shown both by the experimental and the control children used in this study, quite apart from any consideration of the objective findings, convince the investigators that much practical work in music can be done at this early age with encouraging results.

Tests covering songs used in training. Prior to the final pitch and interval tests, the children were tested on their ability to sing the songs which had been taught during training. The tests, covering the entire list of songs, were given twice on different days. Each child was tested individually. During the tests, the experimenter kept a record of the notes that were sung and of the child's reproduction of the rhythm of the songs. A stenographer kept a record of all the words spoken and sung by the experimenter and the children. At the conclusion of the tests, the records yielded a score for each child on reproduction of pitch, rhythm and words.

When the song tests were given, the child was first given opportunity to sing the songs to the accompaniment of an instrument but without verbal prompting. If he failed to proceed without help, or sang incorrectly, the experimenter prompted a second attempt. The stenographer made a record, in proper sequence, of all that was said. In scoring the child's performance two credits were given for each note reproduced without prompting, and one credit was given for a correct response following prompting. One credit was given for each word and rhythmic phrase correctly reproduced. In scoring the song which contained serial repetitions of a single word, credit was given to each group of identical words rather than to each separate word.

When the child's final score on these tests was computed, credit was given for each unit correctly reproduced, whether the item had been sung on both or only on one of the two presentations of the test. When the two repetitions of the song tests were scored separately, the correlations between the first and second presentations were as follows: Words, $r = .83 \pm .05$; pitch, $r = .75 \pm .07$; rhythm, $r = .78 \pm .07$.

The scores obtained on the final song tests were as follows: Pitch, range = 21 to 194; average = 108 ± 41 (maximum possible score, 220). Words, range = 24–75; average = 55. ± 12, (maximum = 75). Rhythm, range = 5 to 14; average = 10.33 ± 2.62 (maximum 14). Earlier in the training period tests were made of the children's ability to reproduce the notes of the songs first introduced. The maximum score on these earlier tests was 10. The average score obtained was 4.67 ±2.96. The correlation between scores of pitch reproduction on these early tests and the final tests described above was .93 ±.03.

At the end of the study all of the children could sing some of the songs and parts of others, while some of them could sing all the songs with little prompting. In a later section correlations between the scores on the above tests and other measures are given.

Examination of the results of the final song tests revealed that the low notes of the songs were reproduced more readily than the high notes. It appeared that the notes Middle C, D and Eb (which are supposed to fall below the child's favored range) scored respectively 68, 80 and 67 per cent., while the higher notes D (above C an octave higher than Middle C), E and F (which have been regarded as well within the child's range) scored respectively only 50, 33, and 25 per cent.

Spontaneous vocalizations

Records of the children's vocalizations while at play, obtained during a total of 100 minutes of observation of each child, with the procedure of recording only those notes which could definitely be verified by means of pitch-pipes when the child sang, hummed, chanted, etc., provided a variety of findings.

The data were first examined to find the number of notes, intervals, and rhythmic measures recorded for each child. The notes sung by the child were scored by allowing one credit for each separate note recorded.

The records also provided a measure of the range of notes covered by each child in his spontaneous singing. This score represents the total number of different notes that were recorded for each child rather than the number of times each note was sung. A similar score was obtained for the number of different intervals which occurred in the child's vocalizations.

The data were further examined to find the number of times series of three notes or more which could definitely be placed within either the diatonic or chromatic scale occurred in the record of each child. Each record was also scored on the number of complete rhythmic measures which the observer had been able to identify clearly while the observations were being made.

Table 5 shows the averages and the average deviations of the various scores derived from the records of the spontaneous vocalizations of the eighteen children. Averages are given first for all vocalizations, including singing, calls, outcries, etc., while the second caption covers only the notes definitely sung, hummed or chanted. Averages are given for the total number of series of notes sung within a scale and separate averages are shown for the number of such series that could definitely be placed in the diatonic and chromatic scales. Series which might be regarded as either diatonic or chromatic were not included in the latter averages.

The results presented in Table 5 show wide individual differences. In a later section, the various measurements represented in the table are correlated with the results of tests and other measures.

The figures showing the frequency of the diatonic and chromatic scales are small, but they are of interest in showing that children at this age do not limit their singing entirely to isolated notes.

Table 6 shows the frequency with which each of the various notes occurred in the spontaneous singing, humming, and chanting and in the children's calls, outcries, etc. Sepa-

TABLE 5

Averages of the total number of notes and intervals, of the number of different notes and different intervals, rhythmic measures, and number of series of notes sung within a scale, occurring in records obtained during 100 minutes of observation of the spontaneous vocalizations of 18 children

	NUMBER OF NOTES IN ALL VOCALIZATIONS	NUMBER OF NOTES SUNG, HUMMED, CHANTED	NUMBER OF DIFFERENT NOTES	TOTAL NUMBER OF INTERVALS	NUMBER OF DIFFERENT INTERVALS	RHYTHMIC MEASURES	SCORES OF NOTES WITHIN A SCALE	DIATONIC SCALE	CHROMATIC SCALE
Range	16-213	7-207	5-15	2-45	1-8	0-11	0-10	0-6	0-3
Average	63	52	11.4	12	3.9	3.9	3	1.61	1.06
A. D.	35	37	2.2	8.8	2.3	3.5	2.07	1.48	1.11

TABLE 6

Number of times each note occurred in the spontaneous singing, humming, chanting and outcries of 18 children during 100 minutes of observation devoted to each child

	MIDDLE C	C#	D	D#	E	F	F#	G	G#	A	A#	B	C	C#	D	D#	E	F	ABOVE F
Singing	0	3	5	4	10	63	30	53	61	172	81	62	84	28	72	3	12	0	3
Chanting and humming	0	0	2	0	8	6	5	6	17	16	15	20	40	8	25	10	6	9	0
Outcries (including talking, calls, etc.)	0	0	4	4	0	2	5	10	12	38	21	29	24	6	22	8	8	6	2
Total vocalizations	0	3	11	8	18	71	40	69	90	226	117	111	148	42	119	21	26	15	5

rate figures are given for frequencies in each category, as well as for all vocalizations combined.

The results shown in table 6 indicate that the spontaneous vocalizations tended to favor a relatively high range of notes. The notes from F above Middle C to D occurred most frequently. It is interesting to note that the children favored lower notes during the tests, as shown in previous sections, and somewhat higher notes when singing during their free play. It appears in table 6 that the higher notes occur relatively more frequently in the children's calls, outcries, etc., than in their actual singing.

TABLE 7

Frequency of occurrence of each interval recorded during observations of the children's spontaneous vocalizations

ASCENDING						DESCENDING					
Major second	Minor second	Major third	Minor third	Perfect fourth	Perfect fifth	Major second	Minor second	Major third	Minor third	Perfect fourth	Perfect fifth
20	24	4	0	2	0	53	46	8	50	3	0

Table 7 shows the number of times each interval occurred in the records of spontaneous vocalizations.

The results presented in table 7 indicate that the descending intervals occurred more frequently than the ascending intervals in the children's spontaneous vocalizations. The closer intervals (seconds and thirds) scored considerably higher than the wider intervals (perfect fourths and fifths). This is in accord with the results obtained on the tests administered during the study.

It further appears in table 7 that the ascending and descending minor second or chromatic interval occurred more frequently than any other interval save the major second.

Reference to table 5 will show that series of three or more notes within the chromatic scale occurred almost as frequently as series within the diatonic scale. The results of the initial and final tests likewise showed a substantial score for the chromatic interval. It appears from all phases of the present study that chromatic intervals are not beyond the singing ability of the three-year old child.

Intercorrelations in the musical behavior of young children

Table 8 shows the coefficients of correlation between various measures and scores obtained for the 18 children who were given training. All coefficients were obtained by the rank-difference method. The P.E.'s which are not entered, range from ±.16 with a coefficient of zero, to ±.02 with a coefficient of .95. To derive the measures represented by the caption "scores on pitch test (and interval test) after training," the children were ranked according to priority in obtaining a perfect score on the pitch and interval tests during the training series.

Most of the coefficients appearing in table 8 are positive. Intelligence quotient shows the lowest median coefficient, while the highest median coefficients are shown for total number of notes sung in spontaneous singing, and scores on rhythm and melody in the final song tests.

Correlation between spontaneous singing, humming and chanting frequencies *and frequency of laughter and overt activity.* From other studies made with the same children, ratings were obtained on the frequency of the children's laughter and general overt activity. The correlation between the children's laughter frequencies and their scores on total number of notes

TABLE 8

Intercorrelations between various measurements obtained in the study of 18 trained children

	PITCH TEST BEFORE TRAINING	INTERVAL TEST BEFORE TRAINING	SCORE ON FIRST TEST OF SONGS	PITCH TEST AFTER TRAINING	INTERVAL TEST AFTER TRAINING	FINAL SONG TEST: MELODY	FINAL SONG TEST: RHYTHM	FINAL SONG TEST: WORDS	SPONTANEOUS SINGING: TOTAL NOTES SUNG	SPONTANEOUS SINGING: NUMBER OF DIFFERENT NOTES SUNG	SPONTANEOUS SINGING: TOTAL INTERVALS	SPONTANEOUS SINGING: NUMBER OF DIFFERENT INTERVALS	SPONTANEOUS SINGING: TOTAL CHROMATICS	SPONTANEOUS SINGING: TOTAL RHYTHMIC MEASURES	INTELLIGENCE QUOTIENT
Score on pitch test before training															
Score on interval test before training	.70														
Score on first test of songs	.52	.70													
Score on pitch test after training	.56	.57	.79												
Score on interval test after training	.47	.53	.68	.49											
Final song test: melody	.51	.58	.93	.76	.80										
Final song test: rhythm	.39	.53	.02	.76	.57	.01									
Final song test: words	.40	.75	.81	.69	.70	.80	.73								
Spontaneous singing: total notes sung	.09	.20	.52	.46	.48	.59	.63	.47							
Spontaneous singing: number of different notes sung	.19	.00	.18	.38	.29	.29	.35	.22	.81						
Spontaneous singing: total intervals	−.05	.18	.39	.27	.41	.51	.55	.33	.93	.72					
Spontaneous singing: number of different intervals	−.04	.18	.48	.26	.26	.50	.60	.37	.84	.61	.93				
Spontaneous singing: total chromatics	.09	.12	.41	.34	.37	.45	.54	.32	.77	.63	.85	.85			
Spontaneous singing: total rhythmic measures	−.03	.39	.40	.23	.21	.29	.41	.32	.72	.50	.67	.62	.53		
Intelligence quotient	.35	.42	.39	.46	.28	.25	.29	.31	.32	.25	.32	.35	−.07	.19	
Median	.37	.475	.52	.475	.475	.545	.56	.48	.555	.32	.46	.49	.43	.395	.315

sung, hummed or chanted during observations of spontaneous vocalizations was −.23; between the latter measure and overt activity scores, the correlation was +.01. It would appear from these figures that there was no significant relationship between the children's tendency to sing, insofar as this tendency was measured in this study, and their tendency to laugh or to engage in physical activity.

Correlations between parents and children. As a further project, the voices of the children's parents were tested. To obtain a rating for the lower and upper ranges of the parents' voices, a numerical score was assigned to each note of the range covered by all the subjects. The highest and the lowest notes were given, respectively high and low numerical values. In rating the performance on the low notes, the highest rank was given to the lowest value. The correlations between the parents and children follow. Fifteen mothers, fourteen fathers, and thirteen cases of both parents combined, are represented in the correlations.

Child's score on first pitch test and voice range of mother = −.24; father +.21; both −.09
Child's score on final pitch test and voice range of mother = +.12; father +.20; both +.29
Child's ability to sing low notes on final test and lower range of voice of mother = +.17; father +.59; both +.62
Child's ability to sing high notes on final test and higher range of voice of mother = +.20; father +.17; both +.31

The coefficients above indicate that the child's final performance correlated higher with parents' range than did the child's first pitch score, and that children tend to resemble their parents more in the place of their voices (whether high or low) than in the range of their voices. The reliability of the coefficients is too low, however, to support any conclusions.

Sex differences

The data were examined for evidences of sex differences. In the pitch tests, the boys scored consistently higher than the girls in number of notes sung and also in ability to sing both high and low notes. Since the number of cases was limited, this difference in favor of the boys may be due merely to chance.

MISCELLANEOUS OBSERVATIONS AND DISCUSSION OF RESULTS

During the course of the study, certain general impressions were obtained, apart from the objective data. Some of these may be stated briefly.

It was frequently observed, in the case of children whose voices were placed low, that to concentrate the training on notes considerably higher than the child's favored range, and then to proceed downward toward this range, was more effective than to concentrate first upon notes immediately above the favored range.

It would appear that the general muscular adaptation involved in singing high notes differs somewhat from the motor pattern involved in the singing of low notes. The progression from low to high notes does not seem to constitute solely a continuous function but appears to entail also a shift in emphasis from one muscle group to another. In the present study it was often found that a child would be able during a period of time to sing some high notes and some low notes without being able to reproduce the notes in between. In a case such as this, it appeared that the child had 'found his voice' for high tones without, as yet, being able to make the transition between the muscle groups respectively involved in the singing of high and low tones.

This statement is offered only as a hypothesis. The authors do not have the empirical data necessary for a thorough treatment of the problem. It is possible that the phenomenon mentioned above may have some relationship with auditory tonal gaps.

Among factors responsible for poor performance in response to musical training, the authors would list the following: Inability to make the transition between high and low notes, as suggested above; presentation of songs pitched too high or too low for the particular child; the tendency of some children to sing too loudly; the failure of some children to give undivided attention to the particular items that are presented.

In the spontaneous singing, snatches of songs taught at home or at school occurred far less frequently than the children's own improvisations. The child's song sometimes related to his current activity or play, and sometimes contained only repetitions of syllables or words. These songs rarely exceeded three measures, but frequent repetitions of the same tune, sometimes with slight variations, were relatively common. The observer obtained the impression that the children sang somewhat more when alone than when in the company of several other children. The activities involving rhythmic motion, such as swinging and teetering, tended to be accompanied by singing more than other types of activity.

There was no evidence that the children strained their voices in singing the extended range of notes introduced into the training period. The practice of encouraging the children to sing softly no doubt helped to insure against strain.

The procedure of pairing a relatively good singer with a less capable child during the training periods seemed to be an effective device. Rivalry was not encouraged, nor did evidences of rivalry appear, but the presence of a child who would sing seemed to promote the efforts of other children.

SUMMARY AND CONCLUSIONS

The present study was undertaken to investigate the ability of three year old children to reproduce pitch and interval, to study the effects of training on this ability, to investigate the content of children's spontaneous singing, and to find relationships between various phases of the child's singing behavior.

Initial tests were given to 48 children. Training was administered to 18 children over a period of 6 months. Each child received 40 ten-minute periods. Tests were given at intervals during the course of training. At the end of the study the trained children were tested and compared with children of a control group who had received no *formal training* since the administration of the initial tests. As a further project, each child who received practice was observed for a period of 100 minutes during his free play, and records were made of his spontaneous vocalizations.

The results show that on the initial tests the ascending notes from middle C to A were sung most readily by the children. This result indicates that children's voices are placed somewhat lower than has commonly been stated in previous writings. In subsequent song tests, and final pitch tests the same tendency to favor lower notes appeared.

The results further indicate that the narrow intervals (seconds and thirds) are sung more readily than the wider intervals (perfect fourths and fifths): that descending intervals tend to be sung more readily than ascending intervals; that the half-step or chromatic interval was sung quite readily in the test situation, and occurred frequently in the children's spontaneous vocalizations. This latter finding does not support the view that the chromatic interval should be excluded from songs for young children.

Training caused a marked improvement in the performance of the children. While the training was in progress it was found necessary to extend the range of notes and intervals covered in the study. On the three repetitions of the initial tests, 11 notes, extending from middle C to F above C an octave higher, were employed. The average number of notes initially sung by the 18 subjects used for training was 4.22 ±2.44; at the end of training the average score on this test was 10.72 ±.11.

The augmented test included the 11 notes of the initial test with four additional higher notes and three additional lower notes, extending from G below middle C to C two octaves above middle C. The score on this extended test, when first introduced after two and a half months of training was 10.67 ±2.76; the final score on this test was 15.50 ±1.78.

On the interval tests the results showed a similarly high improvement with training. In the two repetitions of the initial test, which included twelve intervals (ascending and descending major and minor seconds and thirds, perfect fourths and fifths) the children sang an average of 3.94 ±3.05 intervals, as compared with a final average score of 11.56 ±1.00 after training. An extended test, containing a total of 22 intervals, (including, in addition to the above, the ascending and descending major and minor sixths and sevenths, and octaves) was introduced after two and a half months of training. The average score on this test, when first introduced was 11.11 ± 3.44; on the final test after further training, the average score was 17.44 ±4.00.

The scores of the practiced children were reliably higher than the final scores of the control group.

The records of the children's spontaneous vocalizations showed wide individual differences. The chromatic interval occurred relatively quite frequently. The children tended to favor higher notes in their spontaneous vocalizations than in their performance in tests of songs and of pitch. Relative frequency of spontaneous singing, humming and chanting showed a negligible correlation with frequency of overt activity and of laughter, (records of which were made available through the courtesy of another investigator).

It appeared that children's voices tend to resemble the general trend of the parent's voice (whether high or low) more than their total pitch range. The reliability of all correlations between parents and children was low.

Apart from objective indications of the children's coöperation, as shown by progressive improvement in the test scores, the children gave evidence of interest in the musical exercises.

The results of the study s a whole indicate not only that children's performance in reproducing pitch and interval can be much improved through training, but also that children at this early age are more versatile in the use of their voices than has customarily been stated.

It is not claimed that the marked improvement shown by the children represents a change in capacity or an alteration of native ability. The present study does not answer the question as to whether the child who receives training in singing at an early age will have a permanent advantage over the child whose voice is not trained until later. The findings do suggest, however, that training at the age of three can be undertaken with promising results.

REFERENCES

(1) DAMROSCH, WALTER; GARTLAN, G. H.; AND GEHRKENS, G. H.: Teacher's Book of the Universal School Music Series. New York, 1923.

(2) GIDDINGS, T. P.: Grade school music teaching. New York.

(3) Course of study and syllabus in music for elementary schools. Board of Education, New York City, 1931.

(4) SEASHORE, C. F.: The present status of research in the psychology of music. University of Iowa Studies, 2, 1928, 1-20.

(5) THORN, A. G.: Music for young children. New York, 1929.

(6) Twenty-eighth year book of the national society for the study of education. 1929, 720-722.

Treatment and Progress of an Extreme Case of Functional Anorexia

Helen Streit

"I HAVE seen children whom I am sure would have died from starvation if they had not been fed by insistent perseverance," says Dr. I. A. Abt (1). Such a child was X, according to the statement of her father, who was himself a pediatrician.

X was 2 years and 8 months old when we first met her. She not only lived in spite of herself but, due to her mother's determination and persistence, was kept up to weight and in good physical condition. Her health record was excellent. She had never been sick and was not even susceptible to colds. Her aversion to food started when she was 2½ months old and was so intense at that time that it took the mother two hours to feed her one meal. The milk was given to her from a spoon, as that was the only way she could be made to take it. She was fed 6 times a day, and it was only the extraordinary patience of the mother that prevented the necessity of resorting to tube or rectal feeding.

As X grew older the diet was gradually increased but since she would take only liquid or semi-liquid food, it was necessary to rub all food stuffs through a sieve and then reduce them to the "right" consistency with milk. Because of her great resistence, it was considered that the most practical way of getting her to take a well balanced diet was to mix all of the food together. Milk and cereal formed the basis of the mixture. To it was added egg, vegetables, fruit or meat according to the time of day. The food was well salted but never sugared as she had a particular aversion to sweets. Liver extract and acterol were given separately. In spite of the taste of the former, it was the one item, with the exception of salt, that was taken willingly and even requested.

X was fed from a spoon, sitting on her mother's lap in a half reclining position. She ate in the kitchen. A large rubber apron was tied around her and the food was carefully dropped on the right side of her mouth, in the cheek cavity and not on the tongue. Any change in this procedure caused added resistance and increased the tendency to gag and vomit. In spite of the attention given to these details, gagging, belching, and coughing accompanied each meal and not infrequently the regurgitation of food occurred. On these occasions the rubber apron was removed, a new one substituted, and a second meal begun. The procedure was carried out very calmly in a matter of fact manner and was never varied. If necessary a third meal was given. The mother did most of the feeding but sometimes X was left in charge of an aunt or the maid.

Many devices were used to make the situation as pleasant as possible. Simple games, by way of distraction, were played. An older brother or the maid entertained X in various ways; or if she complained of being too hot, fanned her. The frequent belching was relieved by rubbing her stomach and patting her on the back. When these methods failed, more drastic ones were used. The mother would threaten to leave her to be fed by the maid, perhaps, or deprive her of accompanying her father on his morning calls, if the trouble happened at breakfast time. When the child offered more resistance and threatened to vomit, one or two sharp slaps were administered and the vomiting was actually controlled to a certain extent in this manner. The child might cry slightly because of the spanking, but it was never the occasion for a big scene. Kisses and caresses were bestowed upon her when she was in a non-resisting mood by both father—when he was present—and mother. By the time she was 2 years and 8 months old the number of feedings had been reduced to 4 a day and the average feeding time was around twenty minutes.

Attempts had been made by the parents to establish more normal feeding habits. The good example set by them and by her brother was ineffective except that it gave her a good conversational attitude towards food in general. She would talk about the good food others were eating; she would sit at the table and watch them eat, or go to parties where the children were served the most delectable sweets and never be tempted to put any of them in her mouth. She could be neither forced nor bribed into tasting them. Leaving food lying around in convenient places for her to take as she would offered no solution to the problem, for she never put anything into her mouth. Even as a baby she was unusual in that respect, the parents insist. She did not even compensate by sucking her thumb or fingers. At one time starvation was resorted to. Since X showed no sign of coming to terms during the 2 days when no food was proffered, this method was discontinued and the old regime reinstated.

In spite of the struggle over meals X was a bright, attractive, coöperative child with very pleasant and agreeable ways. She was not given any of the standard mental tests, but observation of her general behavior indicated that she was well above the average mentally.

She had been throughly examined and no trace of a physical difficulty could be found. X-rays had shown that the stomach was of normal size. Though somewhat slow in emptying the motility of the stomach was still normal. No attempt had been made to discover if there was a deficiency in the secretion of gastric juices but it was the father's opinion that that was not a factor. As her vomiting was not accompanied by fever and as the enlarged abdomen and lordosis which are external signs of ptosis and angulation of the intestinal tube were not present, it was believed those conditions were not complicating factors. Her general condition and lack of constipation argued against gastrointestinal atony. She was, furthermore, not an over active, high strung, underweight, underheight child; and although she was pale, her muscles were not soft and flabby. At 2 years 11½ months her height was 36¾ inches and her weight 28½ pounds (nude) making her 1½ pounds underweight for her age and height and giving her an average height for her age according to the Woodbury tables. Her adenoids and tonsils were not enlarged or diseased. Her daily routine was particularly well planned; her diet was well balanced; and she had plenty of outdoor play, plenty of sleep, and was not over stimulated.

The possibility of a very slight throat paralysis was considered but certain facts seemed to indicate that the throat muscles were functioning normally. In the first place she had nursed normally for 2½ months. In the second place she could eat sitting up if she wished to do so, and she did drink water standing up, taking several consecutive swallows without pausing between. In the third place she showed no lack of skill in pronouncing throat sounds, such as hard "g" and "k." Furthermore she had swallowed solids on rare occasions. One time it was a piece of ice; another time, a lemon drop; and still another time, it was 6 beans, which she swallowed one right after the other. Although she never repeated these actions, the fact that she had swallowed solids without difficulty seemed proof that the throat muscles were at least fairly normal.

As the vomiting could be controlled so readily by spanking it did not seem that it could be a symptom of some internal disturbance. The belching could be accounted for by the amount of air swallowed and this in turn because of the manner in which the child was fed. The gagging was probably the result of inadequacies in her swallowing techniques. Lack of taste discrimination and perhaps defective olfaction were considered as possible complications but the development, under our care, of discriminatory reactions with respect to foods make any sensory lacks seem improbable.

A study of the environment offers more convincing cues with respect to possible contributing causes. X nursed normally the first 2½ months of her life. Then because of illness of the mother she was taken off the breast and changed to bottle feeding. The transition was not abrupt, as she had been getting 2 ounces of skimmed cow's milk since the first few days of her life, the mother's milk being too rich. She was not, therefore, being changed to a new type of feeding without some preliminary experience with it. She objected, however, to taking more than 2 ounces from the bottle. Insistence on the part of the mother seemingly caused X to take less at each successive feeding until she refused to take any. Her refusal persisted and the condition became alarming in the eyes of the parents. She appeared to have gone on a hunger strike that was to last indefinitely. A way was found to make her take nourishment without resorting to tube or rectal feeding, i.e. milk was forced into her mouth with a spoon.

Although the parents report that she was not sick at this time it is possible that she contracted a slight infection from her mother who took care of her in spite of the latter's illness. The mother had been under a very severe strain all during her pregnancy because of the sickness of her 9 year old son. He suddenly began having convulsions, with paralysis as an accompanying symptom. Although he was taken to several of the larger clinics on the Atlantic coast, the nature of his illness was never determined. It was diagnosed as infantile paralysis, spinal meningitis and encephalitis by some doctors while others frankly admitted they could not classify it. None of them could suggest treatment for the case and none offered any hope for his recovery. Except for the time when he was visiting the clinics with the father, he was under the complete care of his mother who could do little other than watch him grow worse from day to day. Thirteen days before X was born his condition was so serious that his death seemed only a question of hours. He was completely paralyzed except in one hand which he could move only slightly. His worst convulsions came that day. It was the crisis of his illness. He began then to improve slowly and within a year had recovered completely. The exact nature of the illness was never determined. There is no history of convulsions in either family.

To the strain and anxiety then of caring for this very sick son was added for the mother the illness and death of her father. The latter occurred a few weeks after X was born.

X was a full term baby. Her birth was normal. Her birth weight was 7 pounds. A picture taken when she was only 13 days old shows that she was a particularly wide awake and alert infant.

The mother seems to have suffered from no physical ills following the child's birth. Then she contracted what was called influenza. Although she had a fever of 100 for over a month she did not go to bed during that time. Since she nursed the baby for a week after the fever began it is possible that X was also infected and had the edge removed from her hunger. But we can only speculate on this part of the case.

It is significant that at the onset of X's feeding difficulties the mother was ill and apprehensive. It is probable that she became alarmed when the child resisted foods—a reaction due perhaps to a change in feeding methods—and insisted and forced before she had given the child adequate time in which to make her new adjustment. The mother's apprehension may have been intensified by her access to medical literature where she found reference to children whose loss of appetite and lack of hunger became so serious that they were saved only by tube or rectal feeding.

At any rate once the child's resistance to food was started there were a number of probable factors that entered in to complicate the case and favor the continuance of the habit. The mother seemingly is very jealous of the child's affections. Remarks indicate that she liked her important rôle as the only one who could be depended upon to make X eat consistently. She appears to have enjoyed being a slave to the child and hated to see her grow up. Then, too, she seems to have had some concern for her young husband's reputation—it would never do for a pediatrician to have an underweight child. Because she felt that X must be kept up to weight above all things, she apparently could not bear to see her lose the weight which a starvation regime would have temporarily provoked. The attempted cures failed probably for that reason and also because she was convinced in advance that they would fail.

As for X there was no chance for her to develop a healthy appetite and pleasant experience with food as long as she was fed an ill-tasting and monotonous diet in a manner that justified her vomiting and belching, thus giving the scene even more unpleasant associations. That there would be trouble, furthermore, was suggested by the rubber apron and the special time and place of feeding her. Besides, the child now had a reputation to live up to. She doubtless knew she was different from other people and probably felt she had to remain different for the prestige it gave her. Lastly, contact with the solid foods had been so long delayed she must have felt painfully inadequate in the manipulation of them at three years. At any rate it was clear she did not know how to swallow them.

Believing, then, X's difficulties were largely functional, we took her as our problem and proceeded on that hypothesis. She was separated completely from her family and was put in a new situation with new people who had new attitudes. As these people were unfamiliar with her past life, they would not serve as a constant reminder of her former behavior.

The transition to her new mode of life was made somewhat easier for her by a visit to the home by the author who was to have her in charge. The home situation was studied, as were also the methods used and routines followed; and X's acquaintance was made. A picture book of the Nursery School where X was to spend most of her time with 20 other children ranging in age from two to five years, was shown to her and left for her to look at before she came. She was told she was coming to the school and knew she would see and be with the author. She was not told, however, that she would be separated from her mother as we wanted the separation to be casual and undemonstrative. X left her mother right after she had breakfasted with the latter in the old way. The separation was very casual, the mother slipping away in her car while the child went in to see the Nursery School. Some of the child's most intimate possessions were brought into her new environment. Her own mattress, pillow and bed clothing, as well as a particular book with which she slept insured greater peace of mind to her than would have a totally strange bed. Some of her old toys were also transported to her new home and, of course, a trunk of clothes.

X's adjustment to the new situation and people was very rapid. There was no great emotional disturbance over the change and while she cried for her mother at nap time the first day, and again the next day, on the whole she took the transplantation very calmly and naturally. She referred to her mother a number of times the first week, but with the exception of the first few times, without crying. Then subject of mother and home was dropped until the fifth week, when she began referring to home in a casual way. One time she was scribbling with a pencil and announced she was writing to her mother. Another time she saw a horse go down the street and she invited the author to "come see my pony at home." At this time she began comparing the author's ways with her mother's ways of doing things, telling the former she was not making the bed correctly or helping her to dress in the same way her mother did.

Although we expected to adapt our methods of procedure to the child's response, there were a few principles we set up at the beginning. She was to be given the same food as the other children, a sitting position was to be assumed and she was to feed herself. She was also to eat at regular times and was not to play with the food. Her interest was stimulated by having her set the tables, help in the kitchen, and serve the other children as well as herself. Doing this work was treated as a privilege and not a task. She was encouraged to be independent in other situations and was taught how to bathe herself, comb her hair, dress herself, etc. We depended upon the new environment to dim the old associations and above all we depended upon the examples of the other children to influence the child's mode of response in the new situation.

She conformed very well to our plans and showed herself amenable to the right sort of suggestion. She always came into the dining room and sat down at the table willingly, very often leading the procession. The first morning when tomato juice was served was the only exception. She watched the children from near by and when asked if she would like to sit down with them said, "No." Her refusal was accepted without comment. At dinner time and thereafter she took her seat without objecting. As the food she was served was entirely different from what she was accustomed to getting, she had no undesirable attitudes built about it.

At the beginning we tried to appear disinterested in her eating but more concerned with her conformance to routine. By assuming this attitude we were able to direct the conflicts that were sure to arise over our newly imposed authority to routine matters and establish ourselves there, keeping the meal time situation free from unpleasant scenes. Later we used the drinking situation to further establish our dominance. This plan worked very well and while X had several slight tantrums and two long ones during her stay with us, she never had one at a meal. Her resistance at that time took the form of dawdling and playing with the food. One day we found it necessary to keep her at the breakfast table all morning because she wouldn't drink her milk. The next morning it took her 2½ hours to finish and after that she drank it in fairly good time.

It was not until the middle of the fifth week, after she had learned to swallow solids and we were insisting that she make use of her newly acquired technique, that she put up a defense reaction other than dawdling while eating. She had learned that tantrums availed her nothing. (These tantrums were a response to the new situations. She did not have them at home.) She had also learned that sitting a long time over her food was ineffective. But she could still belch and gag and she thought she could still vomit. Although belching and gagging had disappeared entirely by the fourth week they reappeared the fifth week. She could now swallow all of the food that she put in her mouth but the effort required was still great. It was easier to spit out a bite from time to time than swallow all. In order to stop this tendency we began giving her extra servings in very small amounts—about ¼ teaspoon—and telling her that she could not have her dessert unless she swallowed one bite of the food objected to. She resented the method and responded by attempting to vomit—the first and only time the effort was made. Her surprise at learning that she could no longer vomit at will was almost as great as finding herself sent to bed without finishing her supper, for we never hesitated to deprive her of food when we thought her behavior called for that kind of disciplining.

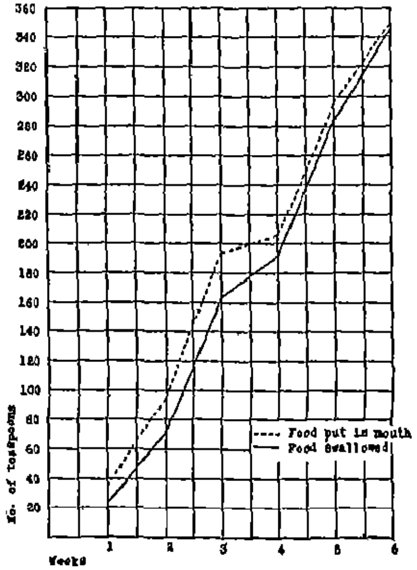

FIG. 1

Her progress was very rapid, and considered in periods of weeks, was steadily upward. (See figure 1.) She varied, however, considerably from day to day, as can be seen from table 1. The variation depended directly on the food served for the day, as she showed food preferences from the very beginning. The consistency of the food and the ease with which it could be swallowed influenced her choice to some extent but not entirely. Some of the foods she preferred most were *the hardest for her to swallow, bacon* and raw vegetables being the best examples.

Her smallest gain was during the fourth week, or immediately after she had discovered that she could initiate the swallowing movement and could make the food go down voluntarily. Up to this time she had stored the food in her cheek and all but that which was very soft or which melted in her mouth like graham crackers,—which she was able to swallow from the very beginning—was taken out again to make room for more. It was while she was eating fruit cut at dinner the eighteenth day that she realized what was happening in her throat when she made the coarser food go down. For the first time she realized what we meant when we told her to swallow her food. The days that followed were spent in trying to master the new technique. Although there was some increase over the preceeding week in the amount of food swallowed the biggest gain was in her control of the throat muscles.

The first foods she started eating were bacon and lettuce, then other raw vegetables and graham crackers. The crackers were the only foods she could swallow at this time. Whatever else was swallowed was by chance or with the aid of milk. In spite of her reputed aversion to sweets it did not take her long to discover that she liked desserts. On the sixth day she took a tiny bite of the thin tapioca custard that was served, exclaimed, "Dat good!" and ate three teaspoons of it. Before the end of the first week she also found that she liked whipped cream, baked bananas and apple sauce. Throughout the treatment we had to make use of these foods, particularly the bacon and desserts, to get her to taste other food she did not care for. Her diet during all but the last week and a half was greatly overablanced in favor of desserts and graham crackers, but since our first problem was to teach her the mechanics of swallowing and give her the right attitude towards food, we had to be guided by her choice and not by strict dietary regulations. Of all the food offered her, we encountered the most resistence to cereal and to eggs in any form except in her milk. They were served to her practically every day and by the sixth week we were beginning to overcome the prejudice. We tried out vitavose in her milk and beef broth before meals, thinking they might be helpful

TABLE 1

Summary of food intake, analyzed in terms of proteins, calories, calcium, phosphorus and iron

DAY	PROTEINS	CALORIES	CALCIUM	PHOSPHORUS	IRON
	grams	*grams*	*grams*	*grams*	*gram*
1	0	0	0	0	0
2	9.3	217	0.231	0.205	0.0027
3	24.7	546	0.747	0.744	0.0048
4	23.4	518	0.720	0.670	0.0037
5	25.7	588	0.825	0.748	0.0030
0	20.7	487	0.030	0.595	0.0035
7	25.5	040	0.770	0.710	0.0038
8	25.4	035	0.770	0 708	0.0038
0	33.1	800	1.077	0.934	0.0044
10	20.3	722	0.877	0 858	0.0041
11	29.3	670	0.877	0.858	0.0041
12	29.4	734	0.920	0.822	0.0042
13	24.5	594	0.720	0.670	0.0037
14	22.7	585	0.630	0.595	0.0035
15	32.9	042	0.930	0.835	0.0047
10	15.0	424	0.325	0.420	0.0037
17	24.0	639	0.670	0.794	0.0040
18	28.7	630	0.731	0.965	0.0047
19	18.6	438	0.548	0.760	0.0037
20	19.9	682	0.457	0.580	0.0035
21	23.6	580	0.704	0.874	0.0044
22	20.2	478	0.615	0.601	0.0023
23	28.3	744	0.786	0.960	0.0047
24	33.3	792	0.881	1.059	0.0048
25	30.0	701	0.716	0.962	0.0053
26	15.9	436	0.474	0.539	0.0025
27	26.7	471	0.504	0.517	0.0031
28	26.5	662	0.766	0.945	0.0047
29	26.5	818	0.791	0 981	0.0051
30	26.9	723	0.750	0 973	0 0048
31	28.6	743	0 775	0 799	0.0038
32	36.8	1,090	0.982	1.280	0 0063
33	27.3	621	0.453	0.684	0.0050
34	41.9	1,107	0.969	0.910	0.0063
35	31.6	925	0.858	0 896	0 0062
36	36.4	1,131	0 872	0 801	0 0088
37	36.3	1,092	1 041	1 042	0.0067
38	29.6	832	0 725	0 744	0.0054
39	35.3	984	0.977	0 953	0 0071
40	35.1	1,037	0 978	0.967	0 0059
41	40.7	1,290	1 115	1.105	0 0087
42	28.8	855	0.754	0 749	0.0045

as appetite stimulants but we met with so much resistence we dropped them. Adding salt to the food encouraged her to taste it, especially in the first weeks, but later was ineffective. In acquiring new tastes progress was slow, the food generally having to be served to her a number of times before she would eat it in any great amount. Sometimes after these trial periods she would find the food to her liking and at times she could be made to eat it in order to get a food she did like. As we considered it essential to keep her in the best condition possible, thinking that only in so doing would we make the best progress, we insisted upon a pint and a half of milk a day the first weeks and only cut it down when it began interfering with the amount of solid food she was eating. We added an egg yolk to the milk twice a day and later 2 tablespoons of cream once a day.

The methods used to induce her to eat changed from week to week and varied from meal to meal depending upon her behavior. At all times we were led by her. She was encouraged and praised frequently but never blamed for her inability to swallow solids. By the end of the second week we found that we had to use a certain amount of pressure but we always tried to keep our dominance from being overbearing. We were satisfied with very little at the beginning, but as she became more adept in her use of silver and in her ability to chew and swallow, we gradually were able to demand more and more of her. Reference to the chart shows how steadily upward her progress was in learning to handle solid food. While the swallowing technique had not become automatic, it was fairly well mastered by the end of 6 weeks. Only 3 teaspoons of food out of a total of 348 were not swallowed, compared to the 9 out of 34 that were removed the first week.

TABLE 2

Comparative progress in food eaten

DAY	MEAL	FOOD SERVED	AMOUNT PUT IN MOUTH	AMOUNT SWALLOWED	NUMBER OF BITES
7	Dinner	Baked banana	1½ tsp.		18
		Pea souffle	¼ tsp.	1¾ tsp.	6
		Corn bread	½ tsp.		12
		Prune whip and	0 tsp.	0 tsp.	0
		Whipped cream	2 tsp.	2 tsp.	44
		Milk	½ pt.	½ pt.	
			4¼ tsp.	3¾ tsp.	
41	Dinner	Baked banana	6 tsp.	6 tsp.	17
		Liver souffle	3 tsp.	3 tsp.	17
		Lettuce sandwich	3 tsp.	3 tsp.	20
		Tapioca custard	9 tsp.	9 tsp.	29
		Milk and 2 tbsp. cream	⅓ pt.	⅓ pt.	
			21 tsp.	21 tsp.	

Although it was impossible to determine the exact amount swallowed it could be roughtly estimated by comparing the amount served with the amount taken out of her mouth. The results shown in the tables can be considered as fairly accurate.

The foods she was eating with some enjoyment at this time were:

- Bacon
- Toast
- Spinach
- Apple sauce
- Stewed prunes
- Baked bananas
- Graham crackers
- Corn bread
- Cottage cheese
- Mashed potatoes

- Rice
- Peas
- Sweet potatoes with apple sauce
- Raw vegetables
  - Lettuce
  - Celery
  - Spinach
  - Cauliflower
  - Cabbage

- All simple desserts
  - Tapioca custard
  - Prune whip
  - Fruit cup
  - Cinnamon apples
  - Grape gelatin
  - Ice cream
  - Cocoa blanc mange
  - Baked custard
  - Apricot whip
- Whipped cream
- After dinner mints

The foods she was learning to eat in substantial servings were:

- Scrambled eggs and eggs in other forms
- Stewed carrots
- Oat meal and other cooked cereal
- Rice flakes

The foods sampled, other than the ones mentioned above, were:

- Chicken
- Chicken dressing
- Steak
- Meat and vegetable loaf
- Liver soufflé and liver in other forms

- Tomato soup
- Spinach soup
- Beef broth
- Salt cracker
- Arrow root cracker

- Egg plant
- Corn meal
- Noodles
- Cake
- Zwiebach
- Jelly

She was not only eating these foods fairly willingly and with evidence of enjoyment for some of them but she was taking average size bites and was making good use of her lips and tongue in manipulating the food and getting it off the silver. Whether or not her subsequent progress in acquiring a healthy appetite and a keen enjoyment of food would have been as fast as her acquirement of the mechanics of the problem we do not know, as the parents decided to remove her from the school at this time. Their appreciation of her improvement was greater than their appreciation of the problem ahead. When she left us she had gained the 2 pounds lost the first few weeks and had gained an additional $\frac{3}{4}$ of a pound.

In evaluating the factors in the treatment that were most effective towards realizing the rapid progress in the short time, there are 3 main points that stand out above the others: (1) The *complete separation from the* family, (2) the daily contact with normal children, and (3) the undivided control during the 6 weeks.

The follow up reports from the home have been unsatisfactory but a letter from the father 6 months later indicated that although she was still the dawdler she was when she left us, her gains in the mechanics of eating had not been lost. He also reported some improvement in the amount of food she was eating and said that she was eating a larger variety than when she left us.

REFERENCES

(1) ABT, I. A.: Anorexia in infants. J. Dis. Child, 1927, 33, 600.

Ability of Children in Color Discrimination

WILLIE MAE COOK

THE practical importance as well as the theoretical interest which is attached to color discrimination scarcely needs emphasizing. So essential is a normal color sensing mechanism that many individuals who are defective in this respect find themselves at a distinct disadvantage in numerous occupations and deprived of the keen esthetic satisfaction which most normal persons find in natural scenery, at the theater, and in many other situations in which color and color combinations are important features. Yet in spite of the great practical and personal importance of color discrimination, it is only within comparatively recent decades that it has become a matter of scientific consideration. Numerous commonsense hypotheses, based on crude observation, have been advanced to account for the physiological and psychological facts of color perception; but recent and more critical investigations have shown that virtually all of the traditional stock theories are either grossly erroneous or in need of serious revision. For example, it was until quite recently believed that defective color vision was more common in men than in women; in fact, it was regarded as a sex-linked characteristic; but improved tests have shown that if there are any sex differences at all in this respect, they are indeed slight. It is also frequently asserted that color-blindness is more commonly found among adults than in children. However, this assumption, like many others, has been based upon only the most casual information concerning the actual color-sensing ability in children, and cannot be accepted until much more extensive and reliable data have been obtained. It appears, therefore, that the experimental study of color vision in children, especially at the early ages, is at present an especially fruitful field for research.

In the past, color vision in children has been studied mainly by the methods of color preference, color naming, and color matching. However, since the color preference has not proved especially productive as an experimental method, only the last two methods will be considered here. Again, contrary to the prevailing opinion, proficiency in color matching appears in children at an earlier age than does accurate color naming. Because of this chronological relationship, in the present study color matching will be considered before color naming both in the historical and experimental sections.

HISTORY OF COLOR DISCRIMINATION

No attempt will be made here to give a comprehensive survey of the previous studies of color matching and color naming. This has been adequately done elsewhere (21, 2). However, it is desirable to review in some detail those investigations which have introduced especially unique or original methods and which seem to have obtained the most significant results. Many of the experiments here reviewed are not conclusive; nevertheless they serve to indicate productive methods and to suggest problems which are amenable to a more strictly quantitative and scientific approach.

Nagel (15) made observations on the development of the color sense of a child. His purpose was to find whether children of two and one-third years of age showed a normal trichromatic color sense, or whether there was any reason to assume a dichromatic or otherwise abnormal color vision. The subject was trained for 5 days to each of the colors red, green, blue, black, and white. The material was in the form of colored papers and was presented in several degrees of brightness and saturation.

The subject was seated before "the mosaic game." The experimenter pointed out red and had the child locate all of that particular color. At the second sitting he was presented with a large number of squares and asked, "Where is red?" The experiment was continued with each color for 5 days, with an average of three training periods per day.

Nagel concludes from his results with the one subject that a child learns to match red with red and green with green rather quickly; that the ability to match blue with blue and gray with gray develops more slowly. He draws no conclusions as to the effect of brightness and saturation differences on color discrimination.

In investigating the color sense of his two children McDougall (13) found that by presenting flowers of different colors, worsted of different colors, and small boxes of different colors that he received a reaction to red as early as the fifth month. "The power to appreciate blue" seems to have appeared as early as the twenty-first week. His final conclusion is "that children are attracted more often by color than by brightness differences."

By means of what he calls the "grasp and reward" method Myers (14) desired to show what colors are confused with red, and to test the brightness sensitivity of his youngster. In the first series of experiments the subject was rewarded with a sip of honey each time she chose red when red was presented with any other color. In the second series presented with 2 gray cards of different brightnesses the child was trained to choose the brighter of the two. He claims to have found that at a very early age (perhaps long before six months) infants are susceptible to relatively small differences in brightness.

Among the other things noted by Woolley (22) in her study of the color perception of one infant is the influence of brightness difference on choice. In a series of colors used, yellow was the brightest color, green next, red third, and blue darkest. The order in which the child chose the colors from greatest to the least number of times was red, yellow, blue, and green.

The child's color preferences did not coincide with the brightness series either in ascending or descending order. In so far as brightness differences influenced choice they must have tended to enhance the darker colors. These tests were made when the child was six months old.

Baldwin and Stecher (2) used the Holmgren color blind test series for a color discrimination experiment. The material consisted of 4 sample worsteds in the colors red, green, yellow, and blue together with 10 shades and tints of each color. Each sample was pinned to the lid of a gray box. In the lid was an opening 1½ inches square to permit the worsteds being dropped out of sight. There was a row of red, green, yellow, and blue in the order named from left to right.

> "It is obvious that the poor success of many children was not due to conditions of the test but to their stage of development. . . . . The saturated greens were found to be the easiest and the pastel shades the hardest. Introspective and spontaneous remarks during the experiment showed that the children regarded the tints and shades such as pink and lavender as separate psychological entities, and were genuinely puzzled by the difference between the sample and the color to be placed."

The age scores increased from 10.3 per cent correct placements at two years to 12.3 per cent at three years, 22.5 per cent at four years, 38.5 per cent at five years, 35.8 per cent at six years. The correct placements at six years show a slight drop.

> "The test measures functions that are relatively independent of the ability to name colors. . . . . Some of the younger children could not name the four samples but placed a number of colors correctly. Other children could call even the more difficult shades and tints by their correct names but could not place them. The test is a little too difficult for our youngest children, probably on account of the large number of colors to be sorted, which necessitates continuous attention for considerable time. It does test some rather complex process of discrimination and comparison, however, and it is consequently of value."

Baldwin and Stecher also conducted a card sorting test using colors from the Woodworth-Wells Blanks. The test materials consisted of a set of pasteboard trays about 1 inch by 2 inches and a pack of 100 cards. A color square cut from a Woodworth-Wells blank was mounted on each card. Each box was marked with a similar color square, and boxes arranged from left to right: yellow, black, green, red, and blue. Cards were piled on the table within a wooden frame and conveniently placed for the subject.

The instructions were: "See these little boxes and these little cards. Let's see how many of the cards you can put in the boxes, each card in the box marked with its own color. Just take any card that's on top and put it where there is one like it." A time limit was set at 5 minutes.

The authors say, "Success in this test is not altogether dependent upon the speed of muscular coordination. Some children hesitate a long time before placing a card, and make errors which they sometimes correct spontaneously, and sometimes recognize only when the experimenter took the wrong card out of the box in order to prevent confusion."

Descoeudres (6), Brian and Goodenough (4), Tobie (20), and Eljasch (7) studied the relationship existing between form and color perception.

Descoeudres' experiment involved the setting up of an experimental situation in which the subject was required to choose between two alternatives in matching a series of objects. Each situation offered equal opportunity for matching either on the basis of form or color, but a choice always had to be made.

Brian and Goodenough set up a similar problem for a group of subjects whose ages ranged from two years to sixteen years of age, and a group of 40 adult women. They found that up to the age of six years matching was done primarily on the basis of color; after the age of six years matching was done primarily on the basis of form.

Eljasch confirms the findings of the earlier investigators that the majority of children between the ages of three and seven years when confronted with the task of matching geometrical figures match them on the basis of similarity in color. "This predominance of color is found no matter whether size or form is the completing characteristic of the objects to be compared."

Tobie's investigation, published in 1927, is one of the most careful experiments reported on the reciprocal effects of color and form. His object was to determine whether children respond more readily to color or to form. Using about 1,000 subjects, he required each to select from an array of different forms, every one of which might appear in several different colors, those which are like the form of a specific color displayed by the experimenter. The records showed whether color alone, form alone, or the correct combination of both factors determined the selections made by the child.

Geometrical forms and outlines of familiar objects were both used as material. The principle conclusions of this investigator were summarized as follows:

> "(1) Up to the age of 3 years 8 months the relative obtrusiveness of color and form determine to which of these factors the child will respond, i.e. which of them will be 'abstracted.' (2) In the age range from 3 years 9 months to 5 years 1 month the child tends to respond to color rather than to form. In the last months of this range the 'color zone' gives way to a period in which form is heeded more frequently. (3) With age 5 years 1 month a developmental phase begins in which, with increasing intellectual development, the ability to respond selectively to either form or color appears."

Conflicting evidence as to the age at which the color names appear in the vocabulary of the child are reported in numerous published studies dealing with the development of color perception. Several investigators experimenting with groups of children, largely European, stated that accurate color naming was acquired rather late. Among this group Binet and Simon (3) considered the correct naming of red, green, yellow, and blue an adequate test for the eighth year. In a later revision of the Binet Scale they placed it in the seventh year. Bobertag (8) replaced it in the eighth year. In America Terman and Childs (19) found it much too easy for the eight year old and in their tentative revision placed it in the fifth year.

Bateman's (1) study, published in 1915, includes the most comprehensive historical summary of the literature on color naming up to that date. Since his experimental work was very carefully executed, both the general discussion and the conclusions which Bateman gives are of particular significance.

His general discussion on color naming may be briefly summarized as follows: (1) Although not usual, children may begin to use color names as soon as the sixteenth month; (2) the twenthieth month is about the average time at which color names at first appear; (3) aptness in acquiring further color vocabulary seems to vary with individual ability; (4) purple, green, and orange are first correctly named around the eighth or ninth year; (5) children as young as twenty-two months name the Binet colors unhesitatingly; (6) American results and foreign results on ability of young children to name colors are not in harmony; (7) boys show less ability at color discrimination than girls.

The final conclusions from the 591 subjects tested by Bateman are that the Binet color test is rightly placed in the fifth year, that school training increases color naming ability, that recognition and naming of colors is weakest in the cases of orange and purple, and that it is probable that American children could be taught to name the Binet colors correctly by the fourth birthday.

Garbini (8), following the same methods of the American and German experimenters, tested 600 six year old Italian children. His results indicate that only 35 per cent could name blue, yellow, pink, orange, and violet correctly.

Baldwin and Stecher (2) also tested the strength of association of color names as determined by the ability to recall the names of color squares. Forty-eight children from three to six years of age were required to name 50 of the colors as given on the Woodworth-Wells color sheets, including red, green, yellow, blue, and black. Nine of the 48 children did not succeed in learning the names well enough to take the test. The time required for naming 50 colors averaged 159.7 seconds at 3 years, 142.1 seconds at 4 years, 92.4 seconds at 5 years, 92.1 seconds at 6 years.

Data from 38 subjects on naming the common signal colors were provided by Luckiesh and Moeller (11). Lights emitting dominantly red, yellow, green, blue-green, and blue were viewed singly and in a group. "The results showed that color names are not standard for a group of observers; that more confusion exists when the color is viewed singly than when viewed in a group of other colors; that the most confusion in naming is found for colors in the vicinity of blue-green; and that confusion also exists at the transitional point between red and yellow."

Interesting results as to the development of the color vocabulary may be had from a study of the vocabulary and language studies published during the last fifty years. Miss Shinn reports that her niece used red at the age of 16 months, Bohn's (1) child used green and yellow at 17 months, and Pelsma's (1) 18 month old child "recognized" blue. The studies of vocabularies of young children throw light on the development of ability to name colors. Bateman (1) has summarized fifteen of the specialized color vocabulary studies.

It may be seen, from the literature which has just been reviewed, that many of the previous studies of color discrimination in children have been either sporadic and unsystematic or have been merely incidental features of juvenile biographies or of various types of mental tests and vocabulary studies. Many of the experiments lack scientific validity because of their failure to control the experimental conditions adequately and because of a lack of standardized materials and procedure. Several commercial concerns are now prepared to supply uniform and standardized color materials which make possible a degree of comparison of the results of various investigators and insure a reliability of results not hitherto attainable.

PROBLEM AND PROCEDURE IN THIS INVESTIGATION

The specific problem of this investigation was the determination of the child's responses to color specimens of different hues but of equal brightness and saturation and to specimens of the *same* hue but of *different* brightness or saturation. Both verbal and non-verbal discriminations were tested by the respective methods of color naming and color matching. As a supplementary problem, an attempt was made to ascertain whether the naming and the matching of different hues were facilitated or hindred by controlling the factors of saturation and brightness.

Subjects

The 110 children who were used as subjects consisted of 45 girls and 65 boys whose ages ranged from seventeen months to six years. General information about the groups may be given briefly as follows:

SOURCE	NUMBER OF SUBJECTS		
	Boys	Girls	Total
1. The Johns Hopkins' Child Institute......	34	16	50
2. University of Georgia Nursery School......	16	12	28
3. Roosevelt Recreation Center School........	10	12	22
4. Good Will Industries Day Nursery........	5	5	10
	65	45	110

	AGE RANGE	I. Q. RANGE
1	2 yrs. 1 mo. to 5 yrs. 4 mos.	97–108
2	2 yrs. 5 mos. to 4 yrs. 11 mos.	85–148
3	1 yr. 5 mos. to 5 yrs. 8 mos.	67–121
4	3 yrs. 10 mos. to 6 yrs. 0 mo.	72–105

Materials

Red, green, yellow, and blue squares of colored paper, $1\frac{1}{2}$ inches by $1\frac{1}{2}$ inches, which had been obtained from the Munsell Color Company and which had been mounted on gray pasteboard cards, 3 inches by 4 inches, were used for both the naming and the matching tests.

The materials employed in the preliminary series consisted of four such colors which any person with normal vision would have called red, green, yellow, and blue. The evaluation of each of these colors, according to the Munsell scale (12), is as follows: red, 4/14; green, 5/8; yellow, 8/14; and blue, 4/8. Two cards for each of the values were used.

The samples used in Series 1 and Series 2 were of various degrees of brightness and saturation. They were made up of red, green, yellow, and blue hues. Munsell gives the following tabular illustration of the relationship between the different brightness and saturation values of these samples:

```
      6/4
5/2   5/4   5/6
      4/4
```

In both the vertical and the horizontal columns, the numerators represent the brightness values; the denominators, on the other hand, represent the saturation values. Thus, for the samples of any given color, the values in the horizontal row represent variations in saturation; the values in the vertical row likewise represent variations in brightness.

The materials for Series 3 consisted of 8 Holgate three-inch color cubes. Two cubes were painted red, two yellow, two green, and two blue. No attempt was made to determine the amount of brightness and saturation of the colors.

Throughout the experiment the accessory gray cardboard used was matched with the gray at the 4/5 value in the Munsell series. The table on which the cards were displayed was always completely covered by a gray cardboard, 22 inches by 28 inches.

Method

Preliminary series. Each subject was brought into the experimental room alone and seated at a small table covered with gray cardboard. Upon this were already placed the four colors which were later to be matched although they were temporarily hidden from the view of the subject by a large piece of gray cardboard. The red sample was placed at the subject's left, the green one next, then the yellow one, and lastly on the extreme right, the blue one. The sample cards to be matched were given to the subject in the same order, i.e., red, green, yellow, and blue.

No attempt was made to equalize the brightness or saturation of the colors used in this series, the only purpose being to present colors which likely would have been frequently encountered by the child in every day experience and to orient the child toward the experiment. The child was first given the red card and instructed to find the color like it among the 4 cards already on the table.

The actual instructions given each subject were as follows: "I have some colors here. See? (Here experimenter removed the gray cardboard covering from the four colors and pointed to them.) Here is another color, too. (Experimenter removed the gray cardboard cover from the red sample card which was directly in front of the subject.) This color is like this one, (experimenter pointed from the sample red card to the red card on the table at the subject's left), isn't it?"

The experimenter took up the red card from the table and said, "Do you see that this card is like this one?" (Experimenter pointed to the sample card and then to the card on the table which the sample card matched.) The red sample card was then removed and the other red card returned to its proper position in the row on the table. The colors were covered again. The green sample was then placed on the table below the row of four colors. Both gray covers were removed. It will be noted that covers were kept over all colors except during the actual presentation of a sample and its matching by the subject. The experimenter said, "See! Another color! Find the color like this one for me. You may pick it up."

If the subject responded correctly, approbation was shown by the experimenter's saying, "Fine!" or, "That's right!" If the subject made an incorrect judgment, it was indicated by the experimenter's shaking her head and saying, "No! No! This (pointing to the sample card) and this (picking up the correct card from the row and placing it by the sample card)! You see this color (pointing to the sample color) is just like this one (pointing to the green just placed beside the sample color)."

When the matching had been completed, the experimenter asked, "What color is this (pointing to red)? And this (pointing to green)? And this (pointing to yellow)? And this (pointing to blue)?" If no response was obtained to the first question, the experimenter said, "I am sure that you know what this color is. What name do you call it?" A record of both matching and naming was kept for this, the preliminary series.

Series 1. The object of this series was to determine the subject's ability to match hues which were varied in brightness and saturation. The six parts of the experimental procedure may be outlined briefly as follows:

Part 1. Four cards, differing in hue, but of the same brightness and saturation (value 5/4).

Part 2. Same as part 1, but a higher brightness value, 6/4.

Part 3. Same as part 1, but a lower brightness value, 4/4.

Part 4. Same as part 1 in all details.

Part 5. Same as part 1, but with a higher saturation value, 5/6.

Part 6. Same as part 1, but with a lower saturation value, 5/2.

Series 2. The purpose of this second series was to determine the subject's ability to match colors when hue and brightness were constant and saturation varied, and secondly, when hue and saturation were constant and brightness varied. In the first part of the series three red cards of equal saturation (5/4) but of brightness values of 6/4, 5/4, and 4/4 respectively, were exposed. A fourth card, with a brightness value of 6/4, was then presented and the subject asked to match it with one of the three cards already on the table. This done, cards of 5/4 and 4/4 brightness value were matched. This procedure was then repeated with saturation instead of brightness as the variable. Parts two, three, and four of Series 2 were exactly like part one except that green, yellow, and blue were used instead of red. No naming was required in this series.

Series 3. This third series of the experiment was planned to check whether or not a position habit had been formed in the color naming and matching. The color cubes were presented in various spatial arrangements. The conditions were as follows: The subject, after entering the experimental room, was seated at the table on which were placed the four colored cubes already covered with gray cardboard. Presenting the subject with the sample red cube and removing the covers from those already on the table, the experimenter said, "I have some blocks here. They are of different colors. This block in my hand is like this one here, (pointing to the red one on the table at the subject's left), isn't it?" As soon as the subject indicated his appreciation of the likeness, the experimenter removed the sample red cube. Following the same method as outlined in the procedure of the preliminary experiment, sample cubes of the colors green, yellow, and blue were presented respectively.

The color cubes were placed on the table in the same order as the color cards in Series 1.

The spatial arrangement of the cubes in the three succeeding presentations was changed. The child was required to match the four samples presented in the sequence: first presentation left to right, red, green, yellow, blue; second presentation left to right, green, red, blue, yellow; third presentation, yellow, blue, red, green; fourth presentation, blue, yellow, green, red.

At the end of the second and the fourth matchings of the four cubes, the subject was asked to name the colors. The particular presentations were arbitrarily chosen by the experimenter on the assumption that any memory habit for color naming would be indicated by his response to a different order of arrangement of the colors on the table. No correction was made of errors throughout the whole of Series 3.

Four sittings were necessary for each subject to complete the preliminary and the three series of the experiment proper. The preliminary series and the first half of Series 1 occupied the first sitting. The second half of Series 1, all of Series 2, and all of Series 3 were given respectively on three subsequent occasions.

RESULTS

Color matching

The experimental situations of this investigation, as previously described, were designed to test the accuracy with which each subject could match color samples, as well as to test his ability to name the samples correctly. Color naming will be reported in the next section. Attention is here directed to the matching which was required in the Preliminary Series, Series 1, Series 2, and Series 3.

The purposes of the color matching tests were: (1) to find the relation between chronological age and the accurateness of color matching and (2) to determine the effect of changes in brightness and saturation, under carefully controlled conditions, on the matching of colors. The following graphic and tabular treatment of the data indicates the results obtained.

Table 1 gives the number and the percentage of correct responses made by the various age groups in both Series 1 and Series 2. The age groups represent six-month intervals, beginning with 2 years and ending with 6 years. The numbers in the double

TABLE 1

Total number and percentage of correct discriminations made by different age groups

AGE GROUP	NUMBER OF SUBJECTS	SERIES 1				SERIES 2			
		Brightness		Saturation		Brightness		Saturation	
		Number correct	Per cent correct	Number correct	Per cent correct	Number correct	Per cent correct	Number correct	Per cent correct
2 yrs. to 2 yrs. 6 mos.	8	51	53	53	55	33	34	36	39
2 yrs. 6 mos. to 3 yrs.	9	60	63	76	70	20	18	35	32
3 yrs. to 3 yrs. 6 mos.	14	156	92	147	87	90	53	85	44
3 yrs. 6 mos. to 4 yrs.	24	274	95	282	98	223	77	191	66
4 yrs. to 4 yrs. 6 mos.	24	287	99	287	99	234	81	232	80
4 yrs. 6 mos. to 5 yrs.	23	256	100	256	100	228	89	166	65
5 yrs. to 5 yrs. 6 mos.	5	60	100	60	100	51	85	50	84
5 yrs. 6 mos. to 6 yrs.	3	36	100	36	100	35	97	33	91

TABLE 2

Percentage of correct matchings as made by 110 subjects on combined scores of Series 1 and Series 2

AGE GROUP	NUMBER OF SUBJECTS	BRIGHTNESS		SATURATION		TOTAL	
		Number	Per cent	Number	Per cent	Number	Per cent
2 yrs. to 2 yrs. 6 mos.	8	84	43	89	46	173	45
2 yrs. 6 mos. to 3 yrs.	9	89	41	111	51	200	46
3 yrs. to 3 yrs. 6 mos.	14	246	73	232	69	478	71
3 yrs. 6 mos. to 4 yrs.	24	497	86	473	82	970	84
4 yrs. to 4 yrs. 6 mos.	24	521	91	519	90	1,040	90
4 yrs. 6 mos. to 5 yrs.	23	484	94	422	82	906	82
5 yrs. to 5 yrs. 6 mos.	5	111	91	110	91	221	91
5 yrs. 6 mos. to 6 yrs.	3	71	98	69	95	140	97

TABLE 3

Percentage of correct matchings for each color according to age groupings

AGE GROUP	NUMBER OF SUBJECTS	PRELIMINARY SERIES				SERIES 1				SERIES 2				SERIES 3			
		Red	Green	Yellow	Blue	Red	Green	Yellow	Blue	Red	Green	Yellow	Blue	Red	Green	Yellow	Blue
2 yrs. to 2 yrs. 6 mos.	8	25	62	50	25	48	60	58	50	33	35	35	39	31	53	62	31
2 yrs. 6 mos. to 3 yrs.	9	66	55	88	66	74	66	72	55	40	13	22	28	60	55	72	66
3 yrs. to 3 yrs. 6 mos.	14	93	93	80	86	89	92	89	89	60	47	47	52	84	82	82	84
3 yrs. 6 mos. to 4 yrs.	24	87	96	96	87	95	97	98	90	75	65	64	66	86	80	89	88
4 yrs. to 4 yrs. 6 mos.	24	100	100	100	100	99	100	90	100	86	80	80	79	100	100	100	100
4 yrs. 6 mos. to 5 yrs.	23	100	100	100	100	100	100	100	100	87	74	80	70	100	100	100	100
5 yrs. to 5 yrs. 6 mos.	5	100	100	100	100	100	100	100	100	83	93	73	86	100	100	100	100
5 yrs. 6 mos. to 6 yrs.	3	100	100	100	100	100	100	100	100	88	100	100	83	100	100	100	100

columns with the word "Brightness" at the top indicate the number and percentage of correct responses when saturation was the variable; the numbers in the columns headed "Saturation," on the other hand, indicate the number and percentage of correct responses when brightness was the variable.

When the scores for brightness difference tests and for saturation difference tests for both Series 1 and Series 2 are combined, the results shown in table 2 appear. This table gives the total number and percentage of correct matchings made by all the subjects on the combined scores of the two series. The percentage of accurate judgments as given in the table indicates a continuous increase in the proportion of correct color matchings with an increase in chronological age.

The percentage of correct matching for each of the four different hues is given in table 3. This summary is made from all four series. The results

TABLE 4

Percentage of correct matchings of red, green, yellow, and blue for each age group based on combined scores of Preliminary Series, Series 1, 2, and 3

	AGE GROUPS								AVERAGES
	1	2	3	4	5	6	7	8	
Red	37	58	70	85	98	95	94	100	84
Green	50	44	71	84	94	90	98	100	81
Yellow	51	55	64	85	93	92	90	100	82
Blue	40	49	72	82	92	89	95	100	81

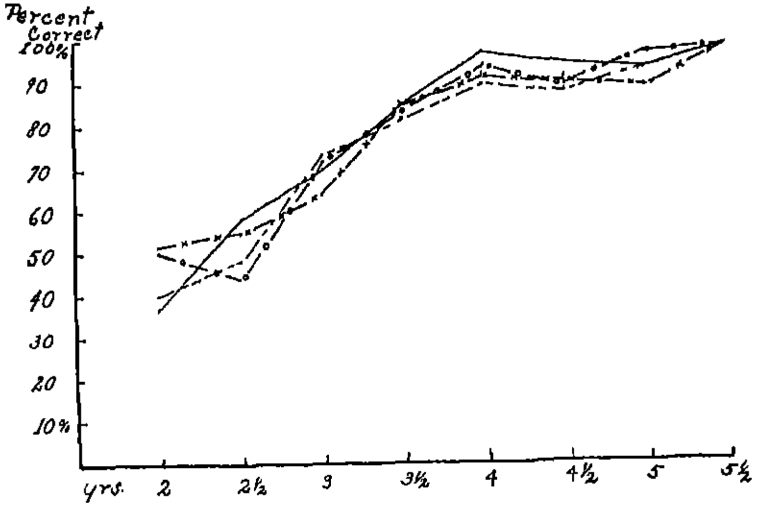

FIG. 1. PERCENTAGE OF CORRECT MATCHINGS OF SUCCESSIVE AGE GROUPS. BLUE- - - -; GREEN—∘—∘; YELLOW—x—x; RED———

indicate that an upward progression of chronological age increases the chances for correct color matching, though not in any direct ratio. With the exception of red in one series (Series 2), no color is matched consistently better or worse by the successively age groups.

In order to summarize concisely the combined scores as obtained on the Preliminary Series and on Series 1, 2, and 3 for color matching, table 4 and Figure 1 are presented. The numbers indicate that the average accuracy for matching for each of the colors is: red 84 per cent, yellow 82 per cent, and both blue and green 81 per cent. These percentages are obtained by combining the results for all age groups and of each of the experimental situations (including hue, brightness, and saturation as variables).

TABLE 5

Number of percentage of correct responses obtained for each of the primary colors

TESTS FOR COLOR NAMING USED IN PRESENT EXPERIMENT	NUMBER OF POSSIBLE CORRECT NAMES FOR EACH COLOR	RED		GREEN		YELLOW		BLUE	
		Total number of correct names	Per cent	Total number of correct names	Per cent	Total number of correct names	Per cent	Total number of correct names	Per cent
Binet	94	57	60	62	66	67	71	58	62
Preliminary	110	85	77	74	67	68	62	79	72
Series 1	660	386	58	416	63	309	47	484	73
Series 3	220	154	70	132	60	151	68	133	60

In general it appears from the data obtained on color matching that accuracy in color matching increases with an increase in chronological age and that no color is consistently matched most accurately by succeeding age groups. There is slight indication, however, that the tendency is present to match colors more accurately when saturation is constant and brightness is varied rather than when brightness is constant and saturation is varied.

Color naming

This section deals with an analysis of the naming of the four primary colors by 110 children. The oldest child tested was 6 years, the youngest 2 years and 1 month. Age was reckoned to the nearest month on the day the first test was given.

Each child was required to give the four color names included in the Binet test as well as to name the colors used in the three experimental situations set up by this investigation. The method of giving one point for each color correctly named was arbitrarily adopted as a scoring device. A correct score was given only when the color specimen was called by its right name, i.e., either red, green, yellow, or blue. This procedure was adhered to throughout the experiment.

Table 5 summarizes the number and percentage of correct responses obtained for each of the primary colors in the Binet test and in the three experimental situations involving color naming. A careful scrutiny of this table reveals the fact that the percentage of correct responses for the preliminary test was higher, on the average, than the percentage of correct responses for the other two color naming tests of this investigation and the color naming on the Binet.

TABLE 6

Correlations between the correct responses obtained from Binet, Preliminary, Series 1 and Series 3

TESTS	CORRELATION	P.E.
Binet and Preliminary.....	.706	.0287
Preliminary and Series 3...	.88	.015
Combined Preliminary and Series 3 with first half of Series 1..................	.89	.013
Combined Preliminary and Series 3 with second half of Series 1...............	.89	.014
First half of Series 1 with second half of Series 1....	.92	.0001

The correlations between the correct responses obtained from these four test situations are given in table 6. These figures indicate a high degree of similarity between the situations under investigation.

In order to arrive at a more concrete notion of the color naming ability of the various age groups, the correct scores for the Preliminary Series, Series 1, and Series 3 were totaled. Subjects grouped according to chrono-

TABLE 7

Average number and percentage of correct naming for the four colors

SUBJECTS GROUPED ACCORDING TO CHRONOLOGICAL AGE	AVERAGE CHRONOLOGICAL AGE	NUMBER OF SUBJECTS	AVERAGE NUMBER OF CORRECT NAMES GIVEN FOUR COLORS	PERCENTAGE OF CORRECT NAMING
2 yrs. to 2 yrs. 6 mos.	2 yrs. 3 mos.	8	8.2	25
2 yrs. 6 mos. to 3 yrs.	2 yrs. 7 mos.	9	12.1	35
3 yrs. to 3 yrs. 6 mos.	3 yrs. 2 mos.	14	15.4	47
3 yrs. 6 mos. to 4 yrs.	3 yrs. 8 mos.	24	17.7	58
4 yrs. to 4 yrs. 6 mos.	4 yrs. 2 mos.	24	20.4	81
4 yrs. 6 mos. to 5 yrs.	4 yrs. 7 mos.	23	24.3	75
5 yrs. to 5 yrs. 6 mos.	5 yrs. 2 mos.	5	18.0	50
5 yrs. 6 mos. to 6 yrs.	5 yrs. 9 mos.	3	20.4	62
SUBJECTS GROUPED ACCORDING TO MENTAL AGE	*AVERAGE MENTAL AGE*	NUMBER OF SUBJECTS	AVERAGE NUMBER OF CORRECT NAMES GIVEN FOUR COLORS	PERCENTAGE OF CORRECT NAMING
2 yrs. to 2 yrs. 6 mos.	2 yrs. 2 mos.	3	5.0	15
2 yrs. 6 mos. to 3 yrs.	2 yrs. 8 mos.	10	7.5	21
3 yrs. to 3 yrs. 6 mos.	3 yrs. 2 mos.	8	12.1	31
3 yrs. 6 mos. to 4 yrs.	3 yrs. 9 mos.	17	12.2	34
4 yrs. to 4 yrs. 6 mos.	4 yrs. 2 mos.	21	14.7	96
4 yrs. 6 mos. to 5 yrs.	4 yrs. 8 mos.	20	27.1	93
5 yrs. to 5 yrs. 6 mos.	5 yrs. 2 mos.	17	28.0	78
5 yrs. 6 mos. to 6 yrs.	5 yrs. 9 mos.	8	28.7	80
6 yrs. to 6 yrs. 6 mos.	6 yrs. 2 mos.	6	26.3	73

logical age and according to mental age, the number of subjects in each group, the average number of correct names given the four colors, and the percentage of correct naming are given in table 7.

It will be noted that in both the successive chronological age groups and the successive mental age groups the color naming is most accurate in the 4 year 6 month to 5 year group and decreases after this age. A possible explanation for the drop lies in the fact that at this age the child begins to add numerous color names to his vocabulary other than the elementary names. As a result he may frequently call red, green, yellow, and blue the various tints and shades of these colors, and in so doing is accordingly deprived of credit. In the last four chronological age groups the scores are consistently lower than in the corresponding mental age groups.

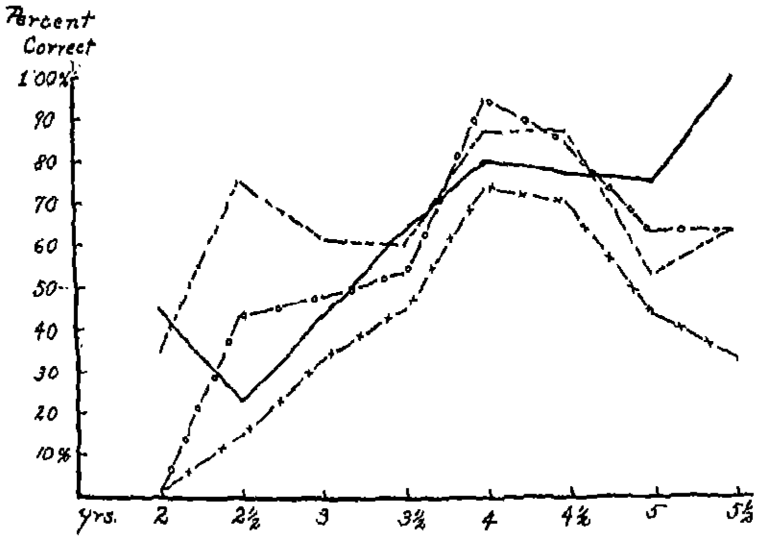

FIG. 2. PERCENTAGE OF CORRECT NAMING FOR EACH COLOR ACCORDING TO SUCCESSIVE AGE GROUPS. BLUE– – – –; GREEN–°–°; YELLOW–x–x; RED————

The fact that red is named most accurately by the youngest and the oldest subjects is shown in Figure 2. Blue maintains a high degree of accuracy with greatest consistency. Yellow is named least accurately by each of the age groups. Green, beginning with a very low percentage of correct responses, increases in accuracy up to the fifth group and ends on an equality with blue. The data represented by Figure 2 are based on the total number of correct names given each color in the Preliminary Series, Series 1, and Series 3.

The effects of brightness and saturation differences on color naming are revealed in table 8. At the ages of 2 years to 2 years 6 months and from 3 years to 4 years 6 months a higher

TABLE 8

The effect of brightness and saturation differences on color naming

AGE GROUPS	NUMBER OF SUBJECTS	SATURATION DIFFERENCE (NUMBER CORRECT)		BRIGHTNESS DIFFERENCE (NUMBER CORRECT)		RED				GREEN				YELLOW				BLUE			
						Saturation		Brightness		Saturation		Brightness		Saturation		Brightness		Saturation		Brightness	
		Total	Per cent	Total	Per cent	Total	Per cent	Total	Per cent	Total	Per cent	Total	Per cent	Total	Per cent	Total	Per cent	Total	Per cent	Total	Per cent
2 yrs. to 2 yrs. 6 mos.	8	23	23	24	24	10	42	10	42	0	0	2	8	1	4	1	4	12	50	11	45
2 yrs. 6 mos. to 3 yrs.	9	44	40	41	37	6	22	5	18	12	44	11	40	7	26	3	11	19	70	22	81
3 yrs. to 3 yrs. 6 mos.	14	78	41	82	49	18	43	17	40	15	36	20	47	18	43	19	44	27	64	26	61
3 yrs. 6 mos. to 4 yrs.	24	152	53	161	56	45	62	42	58	41	57	37	51	26	36	32	44	40	55	50	68
4 yrs. to 4 yrs. 6 mos.	24	230	79	232	80	53	73	54	75	68	94	66	91	47	65	49	68	62	86	63	87
4 yrs. 6 mos. to 5 yrs.	23	211	76	201	72	49	71	40	58	56	81	58	84	46	66	41	59	60	86	62	89
5 yrs. to 5 yrs. 6 mos.	5	35	58	33	55	10	66	9	60	9	60	9	60	7	46	6	40	9	60	9	60
5 yrs. 6 mos. to 6 yrs.	3	24	66	24	66	9	100	9	100	6	66	6	66	3	33	3	33	6	66	6	66

percentage of correct naming of colors is made with saturation as the constant and brightness as the variable. The 2 year 6 months to 3 year olds, and the 4 year 6 months to 5 year 6 months react with correct color names more accurately when brightness is the constant factor and saturation is the variable.

TABLE 9

Total number of color names given each of the four primary colors by the eight age groups

	AGE GROUPS							
	2½	3	3½	4	4½	5	5½	6
Red	5	4	9	9	7	6	6	3
Green	6	5	8	9	6	7	7	4
Yellow	6	5	9	8	10	7	7	6
Blue	5	4	8	8	6	6	9	6

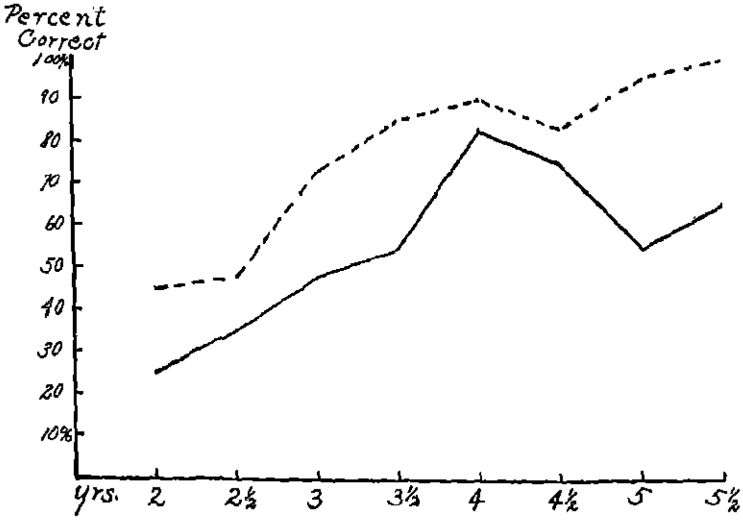

FIG. 3. PERCENTAGE OF CORRECT MATCHING AND NAMING OF ALL THE COLORS BY THE SUCCESSIVE AGE GROUPS. MATCHING----------; NAMING————

Concluding the results on color naming, in table 9 is presented the number of different color names given to each of the four primary colors by the eight different age groups. With an increase in chronological age there is a sporadic increase in the number of color names in the vocabulary.

From the data obtained on color naming the following results appear to be clear cut: (1) Accurate color naming ability increases with chronological age. (2) It may be predicted with a fair amount of certainty that individuals who receive a high score for color naming as measured by any one of the methods used in this investigation will also receive a high rating on all the other naming tests here used. (3) Individuals within the same age group show wide variation in score, e.g., the range in score within 2 year to 2 year 6 months group was from 0 to 30. (4) The children, within the age range studied are likely to call one of the sample primary colors by its own name or by the name of any shade or tint of any primary color. Furthermore, the results of this investigation indicate that there is a tendency to name colors more accurately when saturation is the constant factor and brightness is the variable.

Color Naming and Color Matching

The data obtained for color naming and color matching may be compared in certain respects. When a comparison of the raw scores for naming and matching of colors is made, it is found that in both cases there is a relatively greater number of high scores than low scores. There is a greater frequency of low scores for color naming than for color matching. There is also an indication of a higher correlation between the upper range of scores for naming and matching than between the lower range of scores.

Figure 3 gives the percentage of correct scores for naming and matching colors as obtained with the 110 subjects divided into groups on the basis of age. That color matching received a consistently higher percentage of correct scores than color naming is also indicated.

SUMMARY

On the basis of the data included in the foregoing study of color naming and color matching, the following statements appear to be true:

1. By the age of two years, children are able to match color specimens which differ in hue, brightness, or saturation, with an accuracy of 45 per cent and to name the four primary colors, red, green, yellow, and blue, with an accuracy of 25 per cent. By the age of six years, these two abilities have increased respectively to 97 per cent and 62 per cent.

2. These abilities, however, do not increase uniformly with age, the four-year-olds doing practically as well as the six-year-olds in the color matching and actually excelling them by almost 20 per cent in the color naming. This last fact may be due in part to the relatively lower mental ages and small number of cases in the upper age ranges and in part to the tendency on the part of the older children to use names of related hues, for example, such words as pink, magenta, rose, and scarlet for red, which naturally resulted in a lower naming score in some cases. The training of the child in color discrimination is probably an influential factor in the differences shown within an age group.

3. Although no comprehensive study of color vocabularies was made, there appears, as would be expected, a general increase in number of color words with increasing age.

4. Children of the ages ranging from two years to six years consistently match colors more accurately than they name them.

5. Children of each age can discriminate more accurately between differences in hue than between differences in either brightness or saturation.

6. There appears to be no significant difference in ability to discriminate between brightness and saturation differences, although there is a negligible tendency on the part of the group as a whole to discriminate brightness differences more accurately.

7. There is no regularity in the order

of accuracy with which successive age groups name or match the colors red, green, yellow, and blue. Although one age group may match red, for example, more accurately than any other color, another age group may match another color most accurately. There is, however, no consistent tendency to give one color precedence over the others.

REFERENCES

(1) Bateman, W. G.: The naming of color by children: The Binet test. Ped. Sem., 1915, **22**, 467–486.

(2) Baldwin, B. T. and Stecher, L. I.: The psychology of the preschool child. New York.: D. Appleton, 1925, 125–128.

(3) Binet and Simon: Le developpement de l'intelligence chez les enfants. L'Annee Psychol., **14**, 1–94.

(4) Brian, C. R. and Goodenough, F. L.: The relative potency of color and form perception at various ages. Jour. of Exper. Psychol., **12**, 197–213.

(5) Bush, A. D.: The vocabulary of a three year old girl. Ped. Sem., 1914, **21**, 125–142.

(6) Descoeudres, Alice: Couleur, forme ou nombre? Arch. de Psychol., 1914, **14**, 305–341.

(7) Eljasch, M.: Neue Abstraktionsversuche bei vorschulpflichtigen Kindern. Zsch. f. Psychol., 1927, **105**, 22–41.

(8) Garbini, A.: Evoluzione del senso chromatico nei bambini. Arch. per l'Antr., 1894, **24**, 71–88.

(9) Goddard, H. H.: Two thousand normal children measured by the Binet scale of intelligence. Ped. Sem., **18**, 232–259.

(10) Hall, G. S.: Contents of children's minds on entering school. Ped. Sem., **1**, 139 ff.

(11) Luckiesh, M. and Moeller, I. W.: Naming the common signal colors. J. Opt. Soc. Amer., 1926, **13**, 465–469.

(12) Munsell, A. H.: A color notation. 7th edition. Hoffman Bros. Co., 1926.

(13) McDougall, W.: An investigation concerning the color sense of two children. Brit. J. of Psychol., 1906–1908, **2**, 338–352.

(14) Myers, C. S.: Some observations on the development of the color sense. Brit. J. of Psychol., 1906–1908, **2**, 353–362.

(15) Nagel, W. A.: Observations on the color sense of a child. J. of Comp. Neur. and Psychol., 1906, **16**, 217–230.

(16) Nice, M.: The development of a child's vocabulary in relation to the environment. Ped. Sem., 1915, **22**, 35–63.

(17) Nice, M.: Speech development of a child from eighteen months to six years. Ped. Sem., 1917, **24**, 204–243.

(18) Shinn, M. W.: Notes on the development of a child. Univ. of Calif. Publications in Educ., 1893–1899, **1**.

(19) Terman and Childs: A tentative revision and extension of the Binet Simon scale of intelligence. Jour. Educ. Psychol., **3**, 61–74, 133–143, 198–208, and 277–289.

(20) Tobie, H.: Die Entwicklung der teilinhalten Beachtung von Farbe und Form im vorschulpflichtigen Kindesalter. Beihefte z. Zsch. f. angew. Psychol., 1927, **38**, 103 ff.

(21) Tracy, F.: The psychology of childhood. Boston, 1909.

(22) Woolley, H. T.: Some experiments on the color perception of an infant and their interpretation. Psychol. Rev., 1909, **16**, 363–376.

Brief Reports

A Study of Hand and Eye Preference

PROBLEM

THE study here reported presents the results of a study of the hand and eye preferred by the children at the Vassar College Nursery School for the school year of 1929–1930.

An attempt was made to study the following problems: (1) Does a definite relationship appear between the preferred hand and the preferred eye in the group of young children studied? (2) Do the children in this group who have marked speech defects show a tendency towards left handedness? (3) Does the stability of hand preference show any relationship to the development of speech in the case of a twelve months old child, during the period of observation?

METHOD

1. Direct observations were made of the preferred handedness of 23 children at the nursery school. Most of the observations were made during the noon hour.

2. To twelve of these twenty-three children 3 tests were given in an attempt to determine eye preference. These tests were based on Walter Miles' (1) method for testing ocular dominance which seemed the most practicable for testing pre-school children. The apparatus consists of a V-scope or paper cone which is pressed open by the subject with both hands. However, due to the inability of the children to squeeze the V-scope hard enough to keep the hole at the end of the cone of uniform size, embroidery rings were securely fastened into one of the V-scopes. Thus Miles' test was varied to the extent of using the same V-scope during the entire series of experiments, and the children were not told to lower the V-scope between tests. The subject holds the wide end of the cone over his face, looks into and through the cone at an object placed some feet away. The unconscious sighting is shown by the direction in which the tip of the cone is pointed. The subject has the impression that he is looking at the object with both eyes, but he is really focussing with one eye. This test has the advantage of doing away with errors due to preferred handedness, and seems to have high interest value for all the children who served as subjects.

The situations studied were as follows:

a. In the first experiment Miles' set of ten silhouettes was used—a horse's head, a hand, a crescent, a bicycle, a circle, a cat, a girl's face, an owl, a rooster and a cross. These were placed on a level with the child's head and seven feet away from him. No artificial light was used. The responses of the children to the pictures were recorded as well as the direction in which the tip of the V-scope pointed.

b. In the second experiment the same silhouettes were used, but no attempt was made to show the pictures in the same order. An electric lamp was used to throw direct light on the pictures.

c. The third experiment was given immediately after the second. Ten pictures cut from a magazine were pasted on cards of the same size as those used for the silhouettes. Most of these were colored and all were shaded in contrast to the silhouettes shown in the first and second experiments.

3. Direct observations of use of a spade on the playground were made.
4. Direct observations were made of foot preference as shown in (a) foot lifted first in climbing stairs; (b) foot used on shovel in digging.

RESULTS

In table 1 the subjects are arranged according to age. Observations on the use of the fork and spoon are designated as follows: (1) R— for consistent preference for right hand, (2) L— for consistent preference for left hand, (3) LR— for tendency to start with the left and end with the right hand, (4) RL— showing opposite tendency. Observations on the use of the shovel are recorded with the hand nearest the spade end first—a + sign over the hand directing the work. X

TABLE 1

SUBJECT	OBSERVATIONS—HAND					EXPERIMENTS—EYE		
	Fork	Spoon	Unclassified	Foot	Shovel	Experiment 1	Experiment 2	Experiment 3
A	R-L-R	R	L	R				
B	R	R	R	R				
C	R	R	R	R				
D	R	R	R	R				
E	L-R	R	R			R	R	R
F	L-R	R	L or R	R or L	L-R^{+}	L	L	L
G	R or L-R	R	R	L	L^{+}-R	R	R	R
H	R	R	R			L	L	L
I	R	R	R		L-R			
J	L-R	R-L-R	L			R	R or L-R	R
K	R	R	R		L-R^{+}	R-L	R	R
L	L	L	L	L		L^{-}	L^{-}	R^{-}
M	R	R	R			R^{-}	L^{-}	L
N	R	R	R			R^{-}	R^{-}	R
O	R	R	R					
P	R	R	R					
Q	R	R	R		L-R^{+}	R		R
R	R	R	R		L-R^{+}			
S	R	R	R		R-L^{+}			
T	R	R	R	L	L-R^{+}			
U	R-L	L or L-R	L		R-L^{+}	L	L	L
V	R	R	R					
W	R	R	R	L		R^{-}	L	L

indicates some variation in preferred eye. LR indicates change of focus from left to right.

1. The age distribution of the children and the numbers tested for hand and eye dominance are indicated in table 2.
2. Table 3 gives the results of tests for hand and eye dominance.

TABLE 2

Chronological age levels

GROUP	AGE	NUMBER TESTED FOR HAND	NUMBER TESTED FOR EYE
	months		
I	18–24	1	0
II	25–30	4	1
III	37–48	7	6
IV	49–55	11	5

TABLE 3

Relation of hand to eye dominance

	NUMBER OF CASES	EYE	HAND
Group II.	1	R	R
Group III.	2	R	R
	2	R	L
	1	L	R
	1	L	L
Group IV.	2	R	R
	2	R	L
	1	L	L

In the study of the question: "Is there a correlation between the increased stability of hand preference and the development of speech into words and syllables"? the subject, M H., was a girl observed from the age of twelve months through nineteen months. At the beginning of the observation M. H. was in the babble period and at the end of the experiment M. H. had a vocabulary of fifty-three words. Running notes of M. H.'s use of a preferred hand were taken.

Included as subjects in this study were male fraternal twins, both classed as preferring the right hand, yet one shows preference for the left eye and the other for the right.

CONCLUSIONS

Of the twelve children tested both for hand and eye preference, five preferred the right hand and the right eye; five preferred the right hand and the left eye; one preferred the left hand and had a decided preference for the right eye; while another preferred the left hand and the left eye.

In the attempt to find whether there is a correlation between speech defects and the inhibited use of the preferred left hand, it was found that there was not sufficient material at the school to make any adequate study of the question. Subject L preferred the left eye sixteen times out of thirty tests. This results is inconclusive especially since the last list seemed to show L to prefer the right eye. At present, L has, if not a speech defect, unusually inarticulate speech for her age. In talking she speaks very fast, often omitting parts of words and final consonants. For example, L pronounces Grand Avenue as "Ja Aa"; for yesterday, L says, "ya-ye-daa." The results as shown in the tests seem to be typical of her temperament. At present the only statement as to a preferred hand which seems justified is that when L is given a choice the left hand is preferred. She especially prefers to use the left hand in eating—changing the fork or spoon from the right to the left hand for all delicate eating operations.

Another subject who shows a tendency to prefer the left hand is being taught at home to use the right. No speech defect has resulted.

In regard to the question, "Does the stability of hand preference show any relationship to the development of speech in the case of a twelve months old child?" the observations indicated that as the subject, M. H. became more definitely right-handed, as shown by her use of the fork and spoon at the table, she began to develop a vocabulary. M. H. seems to use her left hand as well as her right, but she prefers her right for eating, whereas in working with the pegboard and fitting toys together, she generally prefers the left hand. The period in which the use of the hands was developing was also one of rapid development of speech.

KATHERINE GORDON.

REFERENCES

(1) MILES, WALTER: Ocular dominance demonstrated by sighting. Jour. Exper. Psychol., 1929, 12, 113-126.

Speech and Music Development of a One Year Old Child

A LITTLE girl, M. H., was brought to the Vassar College Nursery School at the age of twelve months. At the school she came into daily contact with twenty-five other children. The youngest of these children was nearly a year older than she.

PROBLEM

In order to determine if possible whether there was any relationship between the rate and order of acquisition of speech and musical development, this child was observed and a careful running record kept of her responses.

PROCEDURE

Observations for this study were made from October, 1929 to May 15, 1930, that is between the age of thirteen and twenty months. M. H. was observed on an average of two or three times a week, usually in the afternoon, for about two hours at a time. The sounds which she made were recorded, as well as the tone of these sounds. These records were dated. Efforts were made to encourage the child to speak. Sometimes something she wanted was withheld in an attempt to make her ask for it. Real and pictured objects were named over and over again in an effort to build up an association between the objects and their names. Questions were asked and pictures were shown. Sometimes the observer talked to her continually; on other days the observer remained as silent as possible.

Various victrola records were played for M. H., usually those of Kreisler, or some individual singer, so that the tune would be distinct and clear. Her reactions to these were observed. Simple tunes and melodies were sung for her and often repeated many times. Tunes which she hummed were repeated by the observer after her many times. The observer sometimes beat out or jiggled rhythms for M. H. and her reactions were noted. Sometimes the observer attempted to slap out rhythms with M. H.'s hands.

SUMMARY OF RESULTS

The speaking and musical development of M. H. was observed from the age of twelve to nineteen and a half months. This included the babble period as well as the inception and development of speech. During this time her vocabulary grew from no words to fifty-three. These fifty-three words have all been heard and recognized as actually intended to apply to the objects which they designate. M. H.'s comprehension of words is, of course, much greater. She understands simple commands, provided they deal with a comparatively familiar situation. Although able to use her vocabulary M. H. will not speak before strangers or those who are not familiar to her; nor will she speak in unusual situations. Many people oppress and silence her; when playing alone she jabbers most of the time. Thus M. H. uses words to ask for and name things when she is with people whom she knows well, but for social purposes her speech is retarded. This retardation of speech for social purposes may be due to two things. It may indicate that she is shy or it may be due to the fact that in the school where the routine is so carefully planned out most wants can be satisfied without asking for them.

Many words, such as dolly and fish, were first spoken after the observer had named them for her repeatedly. Other words, such as cracker, rubber, and block, were not repeated for M. H. consciously by the observer. However, she probably heard these words many times in general conversation during the year at the school.

Forty-four of the fifty-three words are nouns; Three interjections; two pronouns; two prepositions; one verb; and one adjective. This is to be expected since a vocabulary to be useful must include the names of articles desired. The two prepositions are often used as verbs.

Musically, the sounds M. H. made did not, at first, vary much in pitch, nor did they have much variety of tone. For the most part they ranged over the eight notes of the octave from middle C up.

M. H. showed a favorable and appreciative attitude toward music and rhythm of different sorts. Her spontaneous singing is quite melodious but not usually very rhythmic. She is not tone-deaf and seems to have a fair ear for music, although it is still much too early to judge definitely.

CONCLUSIONS

In any study such as this there are two important considerations. First, the acquisition of words themselves; second, the voice quality and pitch with which these words are uttered and the use made by the child of variations in pitch and quality.

M. H.'s speech and music development seem to be progressing normally. Her speech is comparatively clear, except for the fact that the final consonants are usually omitted. The "k" sound is seldom made, and "t" is often omitted when it occurs in the middle of a word. All the vowel sounds are present. Her acquisition of vocabulary, while late in starting, now seems to be progressing rapidly. Her great interest in everything about her is an added incentive to further speech development.

Not very much can be stated definitely at this time concerning the musical development of M. H. This is due partly to her age. It can only be said cautiously that she appears to enjoy music and to be able to produce musical sounds.

Due to the nature of her vocabulary, M. H.'s speech is, as yet, almost entirely staccato, and therefore little comparison can be made between her speech and rhythm. The individual words are tonal and pure.

Very little can be said, even tentatively, concerning the musical development of a child as young as M. H. It is possible that musical ability does not even develop until the pharyngeal opening of the Eustachian tube of the ear has risen from below the hard palate to above it. Whatever the case may be, one can devise only a few satisfactory experiments to test musical development in a child under two years of age.

MARGARET FITCHEN.

A Study of the Sleeping Habits of Twenty-nine Children of Pre-School Age

A STUDY was made of the daytime sleeping habits of children who had been members of Vassar College nursery school for a sufficient length of time to have become habituated to the daily routine. The time covered was the first semester of the academic year, 1929–1930.

The room in which the children slept was equipped with canvas cots laced both ways in order that the surface was tightly stretched; one sheet folded so that the child lay between the two parts; light weight wool blankets and extra cotton blankets to be used in cooler weather. There were low screens which might be used around the beds of children who needed for any reason to be isolated.

The subjects used in this study were twenty-seven in number. The ages used were computed to October 1, 1929 when the study was begun. The age range was from one year and ten months to four years and five months and the distribution as follows:

AGE	BOYS	GIRLS	
22–30 mos.	3	0	
31–42 mos.	3	10	
43–53 mos.	7	4	
Total	13	14	27

PURPOSE

The study was undertaken with the purpose of adding, if possible, to information on the following points:

1. Average length of nap for three groups of children of different age levels.
2. Average time taken in going to sleep.
3. Percentage of days present, naps were taken.
4. Percentage of children present

who took naps on each day of the week.

5. Average length of nap for each day of the week.
6. Sex differences if any, in length of nap and time taken to go to sleep.
7. Sleeping positions most frequently taken.
8. Possible relationships between:
    a. Time taken in going to sleep and length of nap.
    b. Average length of nap and the possible number of naps (i.e. days present).
    c. Average length of nap and number of days present.
    d. Average length of nap and number of days on which the subjects were awakened by the teacher.
    e. The time taken to go to sleep and the number of days the subjects were awakened by the teacher.
    f. Temperature of sleeping room and length of nap.

PROCEDURE

The observer kept records during the afternoon nap for each child, as follows:

1. Time in bed.
2. Time asleep.
3. Time awake.
4. Unusual occurrences such as elimination or defecation, coughing, masturbation.
5. Temperature of the sleeping room.
6. Weather conditions.

In addition to these records the observer kept running notes on posture, change of posture, mouth open or closed, heavy or light breathing and any significant occurrences.

RESULTS

1. Average length of nap. The *average length of nap for the age* groups was:

	minutes
22–30 mos	74
31–42 mos	73
43–53 mos	74
All subjects	73½

2. Average length of time taken in going to sleep for the age groups was:

	minutes
22–30 mos	38
31–42 mos	36
43–53 mos	41
All subjects	38

3. Percentage of days present, naps were taken:

	per cent
22–30 mos	83
31–42 mos	80
43–53 mos	82
All subjects	82

4. Percentage of children present who took naps on each day of the week.

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
per cent	*per cent*	*per cent*	*per cent*	*per cent*
80	75	80	80	84

5. Average length of nap for each day of the week:

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
minutes	*minutes*	*minutes*	*minutes*	*minutes*
74	75	75	75	73

6. Sex differences were as follows:

AGE GROUP	AVERAGE LENGTH OF NAP		AVERAGE TIME TO GO TO SLEEP		PER CENT DAYS PRESENT WHEN NAP WAS TAKEN	
	Boys	Girls	Boys	Girls	Boys	Girls
	minutes	*minutes*				
22–30 mos.	74		38		83	
31–42 mos.	80	70	33	38	80	80
43–53 mos.	77	69	43	39	87	72

7. Sleeping positions during nap. There were 244 records of posture during sleep made. 107, or 44 per cent of the total of these, recorded the child as lying on his right side; 77, or 31 per cent were on the left side; 38, or 16 per cent were on the stomach and 22, or 9 per cent were on the back. 203 records were made of mouth open or closed. There were 149 or 73 per cent mouth open and 54 or 27 per cent mouth closed.

The correlation of length of nap with time of going to sleep and with temperature of room showed no significant relation. Age and sex differences were not marked.

Ethel Scott.

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